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LIVE, VIRTUAL, AND CONSTRUCTIVE-TRAINING ENVIRONMENT: A VISION AND STRATEGY FOR THE MARINE CORPS

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September 2014

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Through researching Marine Corps policies and educating numerous Marines and civilians throughout Headquarters Marine Corps and the operating forces, the author was able to determine that few personnel are aware of LVC-TE and there is no process in place to ensure appropriate representatives are educated on LVC-TE or are provided the opportunity to offer inputs to the requirements process. With root problems identified and by gathering information on potential technological improvements and training applications for LVC-TE, the author was able to devise numerous recommendations that provide a comprehensive vision and strategy for LVC-TE.

Recommendations are made for a comprehensive Marine Corps vision and strategy with a focus on assigning a capabilities integration officer to LVC-TE and adherence to an integrated process in order to ensure the correct requirements are identified, prioritized, and implemented in an efficient manner.

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LIVE, VIRTUAL, AND CONSTRUCTIVE-TRAINING ENVIRONMENT: A VISION AND STRATEGY FOR THE MARINE CORPS

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Submitted in partial fulfillment of the requirements for the degree of

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LIST OF ACRONYMS AND ABBREVIATIONS

3D	three-dimensional
AAR	after action review
ACE	aviation combat element
ACMC	Assistant Commandant of the Marine Corps
ADVTE	Aviation Distributed Virtual Training Environment
AFATDS	Advanced Field Artillery Tactical Data System
AFB	Air Force Base
AI	artificial intelligence
AITT	Augmented Immersive Training Team
AO	area of operations
ARES	Augmented REality Sandtable
ARL	Army Research Lab
ATF&PD	Advocacy, Transition, Fiscal and Personnel, Budget, Operations Division
ATS	Aviation Training Systems
AVN	Aviation
BFT	Blue Force Tracker
BSC	Battle Simulation Center
C2	command and control
C2ID	Command and Control Integration Division
C2PC	command and control personal computer
C4I	command, control, communication, computers, and intelligence
CACCTUS	Combined Arms and Command and Control Training Upgrade System
CBA	capabilities based assessment
CCB	configuration control board
CCS	Combat Convoy Simulator
CD&I	Capabilities, Development, and Integration
CDD	capabilities development document

CEAB	Command Element Advocacy Board
CFLCC	coalition forces land component commander
CG	commanding general
CIO	capabilities integration officer
CLR	Combat Logistics Regiment
CMBG	Canadian Mechanized Brigade Group
COA	course of action
COAG	combined operational advisory group
COC	combat operations center
CONOPS	concept of operations
COP	common operating picture
COTS	commercial off-the-shelf
CSC	Command and Staff College
CVTS	Combat Vehicle Training System
DASC	direct air support center
DC	Deputy Commandant
DMCS	Director, Marine Corps Staff
DOD	Department of Defense
DOTMLPF-P	doctrine, organization, training, materiel, leadership and education, personnel, facilities, and policy
DSR	distributed soldier representation
DVTE	Deployable Virtual Training Environment
EdCom	Education Command
EF-21	Expeditionary Force 21
ELO	enabling learning objective
EWS	Expeditionary Warfare School
EWTG	Expeditionary Warfare Training Group
FoF	Force on Force
GAO	Government Accountability Office
GCE	ground combat element
GO	general officer

FINEX	final exercise
FMID	Fires and Maneuver Integration Division
FOC	full operational capability
FY	fiscal year
FYDP	Future Years Defense Program
HQMC	Headquarters Marine Corps
I&I	inspector and instructor
I&L	Installations and Logistics
IA	information assurance
ICD	initial capabilities document
I/ITSEC	Interservice/Industry Training, Simulations, and Education Conference
IPC	initial planning conference
IPT	integrated product team
IWOC	Infantry Weapons Officer Course
JIIM	joint, interagency, intergovernmental and multinational
JTAC	join terminal air controller
LCE	logistics combat element
LID	Logistics Integration Division
LSE-14	Large Scale Exercise 14
LVC	live, virtual, and constructive
LVC-TE	Live, Virtual, and Constructive—Training Environment
M&RA	Manpower and Reserve Affairs
M&S	modeling and simulations
MAG	Marine Air Group
MAGTF	Marine air ground task force
MAGTFTC	Marine Air Ground Task Force Training Command
MARFOR	Marine Forces
MAWTS-1	Marine Aviation Weapons and Tactics Squadron 1
MCAGCC	Marine Corps Air Ground Combat Center
MCAS	Marine Corps Air Station

MCATS	Marine Corps Action Tracking System
MCICOM	Marine Corps Installations Command
MCLOG	Marine Corps Logistics Operations Group
MCMSMO	Marine Corps Modeling and Simulations Management Office
MCO	Marine Corps order
MCPP	Marine Corps planning process
MCSC	Marine Corps Systems Command
MCTIMS	Marine Corps Training Information Management System
MCTSSA	Marine Corps Tactical Systems Support Activity
MCWL	Marine Corps Warfighting Laboratory
MEB	Marine Expeditionary Brigade
MEF	Marine Expeditionary Force
MEU	Marine Expeditionary Unit
MID	Marine air ground task force Integration Division
MOVES	Modeling, Virtual Environments, and Simulation
MPC	mid-planning conference
MROC	Marine Requirements Oversight Council
MSC	major subordinate command
MSTP	Marine air ground task force Staff Training Program
MTESD	Marine air ground task force Training and Educations Standards Division
MTWS	Marine air ground task force Tactical Warfare Simulation
NAWCTSD	Naval Air Warfare Command Training Support Division
NPS	Naval Postgraduate School
O&M	operations and maintenance
OAG	operational advisory group
ONR	Office of Naval Research
OST&E	Operating Force Science, Technology, and Experimentation
P&R	Programs and Resources
PJM	project manager
PM TRASYS	Program Manager, Training Systems

PoC	proof of concept
POC	point of contact
PP&O	Plans, Policies, and Operations
R2P2	rapid response planning process
RLT	Regimental Landing Team
ROMO	range of military operations
RUGUD	rapid unified generation of urban databases
S&T	science and technology
SAVT	Supporting Arms Virtual Trainer
SIAT	Systems engineering, Interoperability, Architecture, and Technology
SITE	Squad Immersive Training Environment
SME	subject matter expert
SNCO	staff non-commissioned officer
SPMAGTF	special purpose Marine air ground task force
STTC	Simulation and Training Technology Center
T&E	training and education
T&R	training and readiness
TECD	Training and Education Capabilities Division
TECOM	Training and Education Command
TEROC	Training and Education Requirements Oversight Council
TLO	terminal learning objective; training system liaison officer
TMT	training management team
TSC	Training Support Center
TTP	tactics, techniques, and procedures
VBS2	Virtual Battlespace 2
VV&A	verification, validation, and accreditation
WG	working group
WIPT	working integrated product team

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I. THE LARGER PROBLEM

The Marine Corps regularly finds itself adopting new operational concepts in order to adapt to new threats and changing resource conditions. The Marine air ground task force (MAGTF) remains at the center of these adaptations; the MAGTF is how the Marine Corps deploys and fights. MAGTFs consist of four elements: command element (CE), ground combat element (GCE), aviation combat element (ACE), and logistics combat element (LCE). MAGTFs are scalable as required for the mission and are provided in the forms (from smallest to largest) of Special Purpose MAGTF (SPMAGTF), Marine Expeditionary Unit (MEU), Marine Expeditionary Brigade (MEB), and Marine Expeditionary Force (MEF). The latest Marine Corps operational concept is Expeditionary Force 21 (EF-21) and it is presented in a capstone concept document dated 4 March 2014. In EF-21, the MEB is the focus of effort for force deployment with the expectation that MEBs will be composited from smaller MAGTFs (SPMAGTF, MEU) and additional forces (CMC, 2014). How the Marine Corps achieves training and readiness (T&R) to support the EF-21 concept under tightening resources remains a significant concern.

Live, Virtual, and Constructive (LVC) training offers an exponentially greater number of capabilities to support MAGTF T&R than current standard live training and stand-alone simulators and simulation offer, specifically under resource constraints. The Marine Corps has demonstrated a desire to develop and implement LVC capabilities via the LVC-Training Environment (LVC-TE) but this desire has not been shared institutionally. There is then a significant danger of the Marine Corps moving forward to develop LVC-TE without actually meeting the needs of Marines and without proper integration to support EF-21.

Since late 2013, there have been considerable gains in the LVC-TE concept and capability yet there remains a substantial gap for the Marine Corps to suitably develop the LVC-TE. Specifically, the Marine Corps lacks a full vision and strategy for development and implementation. To provide recommended solutions for this gap, it is necessary to

understand what LVC training is, why the Marine Corps desires these capabilities, and what the overarching problems are.

A. WHAT IS LVC?

LVC has become a broad term for the integration or interoperability of simulators and simulations (i.e., training systems) and command, control, communications, computers, and intelligence (C4I) systems. Current Department of Defense (DOD) definitions (ONR, 2011) break LVC down as:

- Live Simulations, which represent the natural physical environment in which individuals or teams operate their systems and platforms for rehearsal and training purposes. Typically, these environments are closely similar to the expected operational environments, with modifications to the systems and platforms that support performance assessment and maintain range safety.

- Virtual Simulations, which are synthetic environments that include the replication of warfighting equipment and operational environmental conditions; allows for the sharing of a common environment which multiple users can access; and supports interactions with simulated entities (including objects, avatars, and equipment) that mirror, in response fidelity, those that would occur in the real world.

- Constructive Simulations which are simulated forces that respond to trainee actions. Typically, real human inputs are needed to fully operate these simulated forces which then carry out the resultant actions in a synthetic environment. Semi-automated Forces are one example of constructive simulations; Wargaming models are another example.

As technological growth and security threats in the 21st century brought tremendous growth in the number of C4I systems and their capabilities, there was a similar impact and proliferation in training systems. LVC can become very convoluted so I will focus on basic tenants for the Marine Corps. To simplify the DOD definitions: live is real people operating real systems, virtual is real people operating simulated systems, and constructive is simulated people operating simulated systems. Marines are already well ingrained with live training—new caveats are that the Marine Corps is improving its abilities to instrument personnel, weapons, and other systems in order to network them for improved command and control (C2), diagnostics, and after action reviews (AAR).

Unbeknownst to many, the Marine Corps has been supporting MEB, MEF, and other major subordinate command (MSC) training exercises and mission rehearsals for years by combining live and constructive training. The new component that LVC brings is the full interoperability of virtual systems along with live, constructive, and C4I systems. This is an extremely important evolution in concept and capabilities.

1. Live Training

Live-fire and maneuver is certainly the most realistic tactical training for Marines. If you ask Marines and their leaders how they prefer to train, they will pick live training. Live training has constraints and limitations though. It requires weapons, vehicles, aircrafts, and other systems that need ammunition, fuel, and maintenance for employment and sustainment—this becomes resource intensive and often requires funding and time that the Marine Corps cannot afford. Training areas and ranges often provide limitations on where and how live training can be conducted—they can limit the type of weapons and ammunition allowed, they can limit battlefield geometry, they can limit the unit size and this can all lead to unrealistic employment of forces. The number of training areas and ranges available versus the number of units needing to use them is often not adequate either. Safety issues can add restrictions and additional personnel requirements. These constraints and limitations mean that live training (by itself) is often predictable and does not train the entire MAGTF for uncertainty.

2. Live and Constructive Training

When large commands need to conduct exercises, the necessary forces are often not available, so constructive forces fill the gap. This allows the commander and staff to execute at their level while subordinate staffs and units are simulated. Additionally, live and constructive training can support many joint and coalition training objectives and can be conducted in a distributed environment (i.e., across multiple geographic locations). Because constructive forces are represented within computer systems or on map boards, they are not physically constrained to the same training areas and ranges that live forces are, so the constructive aspect allows large commands to operate more realistically. The use of constructive forces does not mean that there is a void of additional personnel

needed—personnel are still needed to act on behalf of subordinate commanders, staff members, and units. Often these personnel are contractors or junior Marines serving in two or three levels above their normal billet and they are typically not free to make their own decisions but are just expected to follow the script. A negative aspect with constructive training then is that the higher level staff and commander are not being stimulated by the true thoughts and actions of subordinates.

3. LVC Training

The integration of virtual training systems is what distinctly sets LVC apart from current training capabilities. Whereas resource constraints limit live training and the lack of real people performing their real jobs limits constructive training, virtual training allows real people to perform their real jobs in less constrained environments. Through virtual training, a tank commander can employ forces in any geographic location, a battalion commander can execute C2 anywhere in the world while conducting fire support planning and coordination, and a pilot in Miramar, California can provide close air support for a Joint tactical air controller in Okinawa, Japan while they are both virtually immersed in North Korea. It is this latter example of virtual interoperability that can exponentially improve training. When multiple systems are linked together so that Marines are able to see and communicate with each other in the same virtual environment (whether in adjacent rooms or 2,000 miles apart), the Marine Corps can achieve many of the same qualities that make live training so advantageous but do so in the environment of its choosing, in a quickly repeatable and variable fashion, with fewer resource constraints—essentially, the Marine Corps can train as it would fight with additional time savings and cost avoidance. LVC can be a significant MAGTF T&R capability if fully integrated into the Marine Corps.

B. WHAT IS LVC-TE?

LVC-TE is the approved Marine Corps program to develop and employ LVC concepts and capabilities. Based off of a Capabilities Based Assessment (CBA), the LVC-TE Initial Capabilities Document (ICD) was signed by the Marine Requirements Oversight Council (MROC) in 2010. The LVC-TE Concept of Operations (CONOPS)

was recently signed on 17 July 2014 and Figure 1 provides a graphic of the LVC-TE operational view provided in the CONOPS; there is a clear focus on MAGTF support (MROC, 2010).

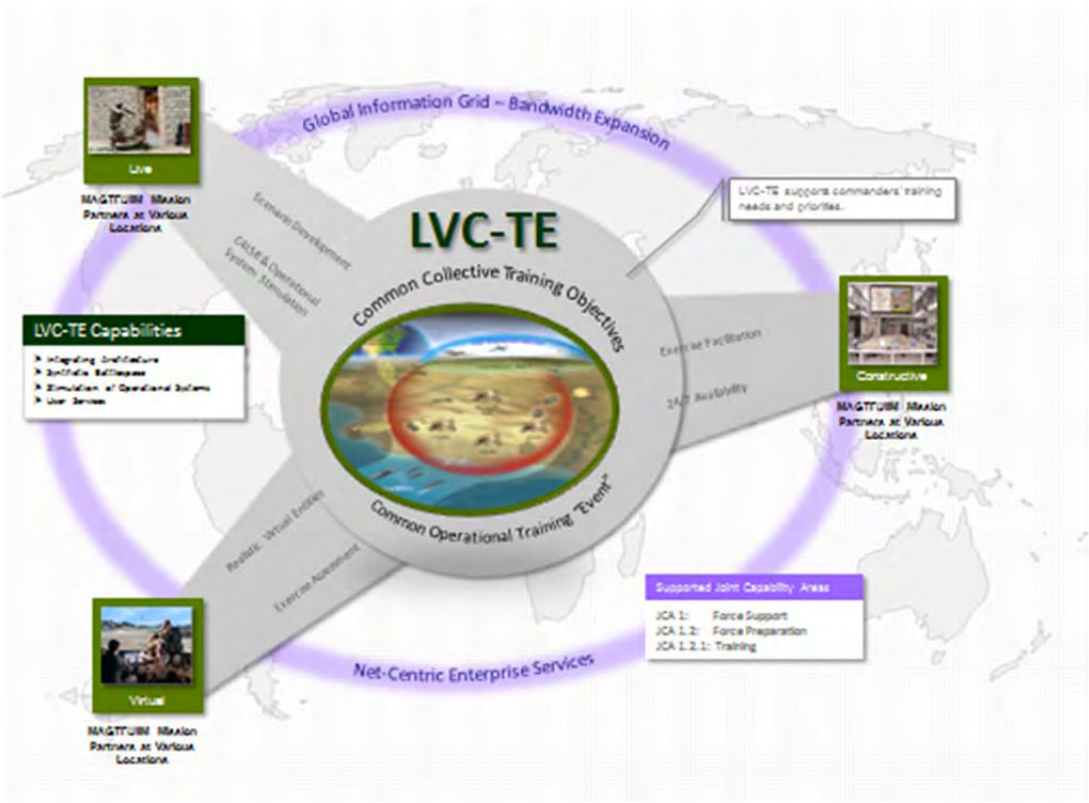

Figure 1. High-Level Operational Concept Graphic (OV-1) for LVC-TE (from TECOM, 2014)

1. Current LVC-TE Lead Organizations

In the development and execution of LVC-TE, Training and Education Capabilities Division (TECD) is the requirements sponsor for non-standard training systems and LVC-TE (CMC, 1991). TECD is a division under the headquarters of Training and Education Command (TECOM) and TECOM is a subordinate command under Marine Corps Combat Development Command (MCCDC). The commanding general (CG) of MCCDC is also Deputy Commandant (DC), Capabilities Development and Integration (CD&I). Figure 2 provides an overview of the CD&I and MCCDC organizational structure. Program Manager, Training Systems (PM TRASYS) is the

materiel solution manager for training systems and LVC-TE. PM TRASYS falls directly under Marine Corps Systems Command (MCSC). Figure 3 provides an overview of the MCSC organizational structure. The Office of Naval Research (ONR) is a key contributor to LVC-TE as a technology developer. Figure 4 provides a representation of the relationships between CD&I, MCSC, and ONR.

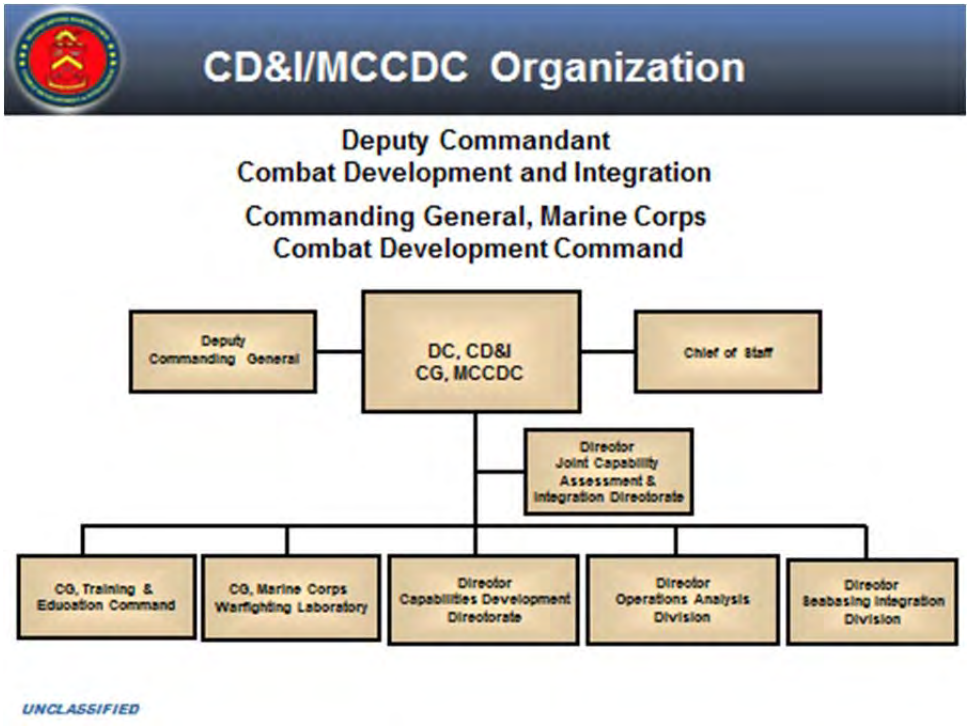

Figure 2. CD&I and MCCDC Organization Chart (from HQMC, 2012)

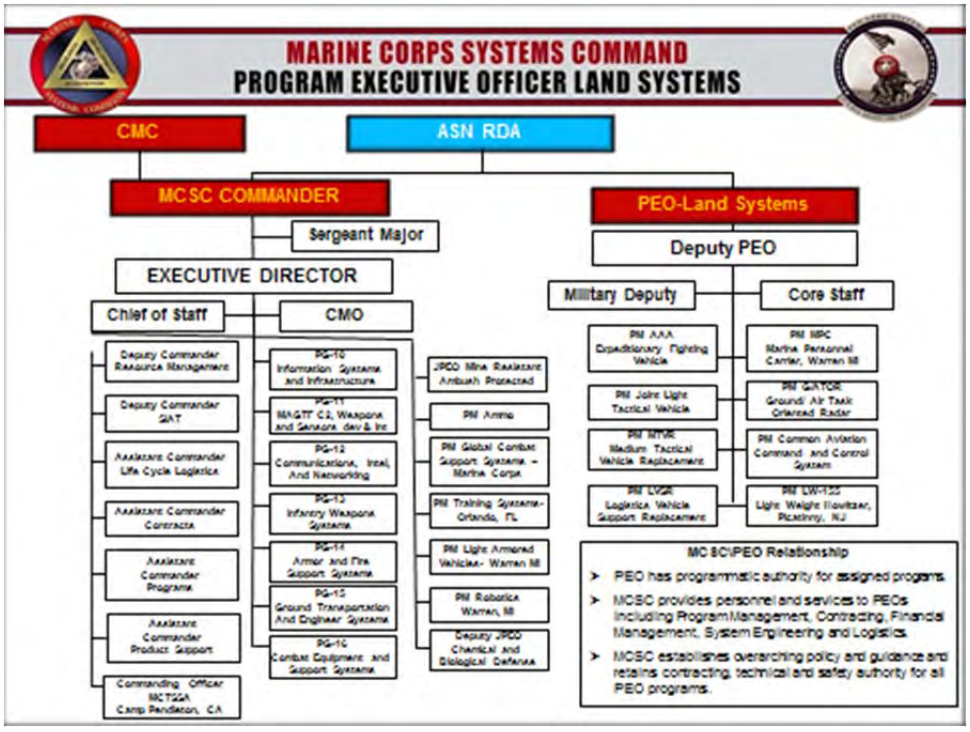

Figure 3. MCSC and PEO Land Systems Organization Chart (from MCSC, 2013)

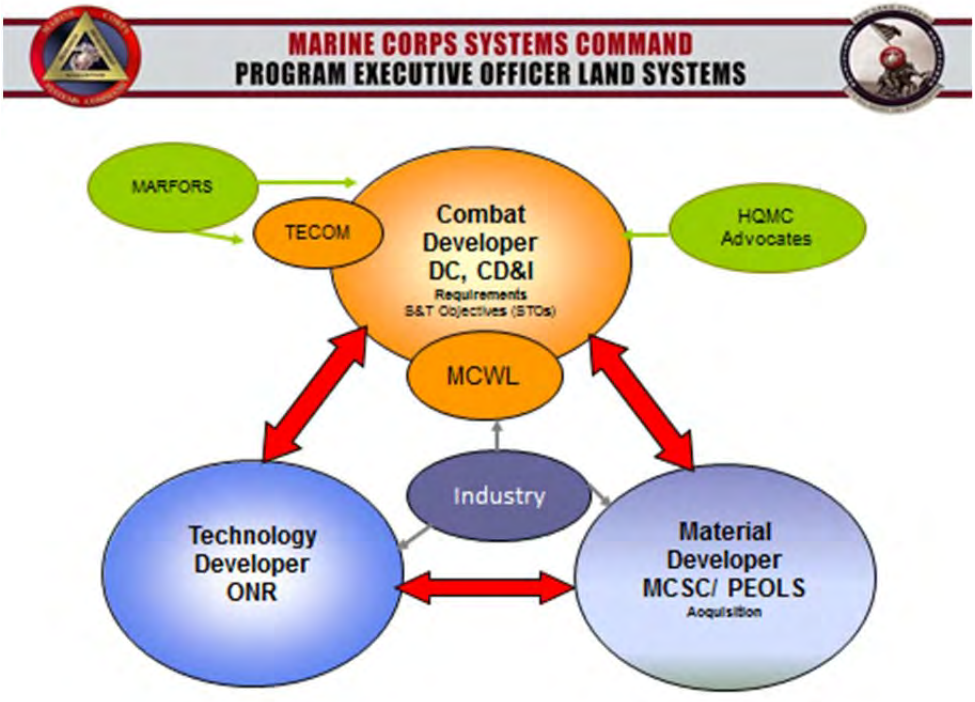

Figure 4. Relationships between CD&I, MCSC, and ONR (from MCSC, 2013)

2. CBA Results

As stated in the ICD, the CBA identified four necessary capabilities for LVC-TE (MROC, 2010):

a. Integrating Architecture

Provides the ability to allow for the easy, rapid and seamless integration of the live, virtual and constructive domain mission partners.

b. Integrated Dynamic Virtual and Constructive Synthetic Battlespace Representations

Provides the ability to replicate entities across the full range of military operations (ROMO) when executing fully integrated LVC operations.

c. Integration and Stimulation of Operational Systems

Provides the ability for warfighters to train and execute mission rehearsal events utilizing their operational systems.

d. User Services

Provide the ability to easily and rapidly conduct collaborative planning, preparation, execution, and assessment for LVC training, exercise, and mission rehearsal events.

These capabilities were further analyzed and 23 enterprise-level capability gaps were produced (MROC, 2010). These gaps are presented and discussed throughout the ICD and provide a foundation for the materiel solution.

3. LVC-TE Gap Analysis

The 23 capability gaps are important but are not necessarily essential to this discussion. What is essential is the further analysis conducted and presented through the CONOPS. In order to properly address gaps and integrate capabilities across the Marine Corps, DOTMLPF-P analysis are conducted. DOTMLPF-P is a standard military term and it is a standard military process to assess impacts across Doctrine, Organization,

Training, Materiel, Leadership and education, Personnel, Facilities, and Policy (CJCS, 2012). To recognize the impact that LVC-TE will have across the Marine Corps and the criticality of integration, the DOTLMPF-P assessment needs to be looked at.

Though not all-inclusive, the following items provide a number of the gaps as analyzed against DOTMLPF-P and presented in the CONOPS. The affected DOTMLPF-P areas are provided in parentheses (TECOM, 2014a).

- Lack of systems designed to support comprehensive Mission Essential Tasks (METs) and/or collective T&R events. (T), (M), (P), and (F)
- Lack of federation capability training systems. (T), (P), and (F)
- Limited understanding of LVC-TE linkages. (T)
- Lack of the means for MAGTF distributed training, exercise and education. (O), (M) and (F)
- Lack of systems for integrating training, exercise, and education capabilities across LVC-TE domains to support multi-echelon (horizontal/vertical integration) training throughout the MAGTF. (O) and (M)
- Lack of an existing, integrating architecture. (D), (M) and (F)
- Lack of realistic or incomplete entity behaviors. (M) and (P)
- Lack of required M&S entity fidelity and resolution. (M)
- Lack of a complete set of Diplomatic, Information, Military, Economic and Political, Military, Economic, Societal, Information, Infrastructure (DIME/PMESII) entities. (M)
- Lack of a federated dynamic virtual and constructive synthetic interoperable distributed operational environment. (D), (M) and (F)

- Lack of specific terrain coverage, as needed. (M)
- Lack of adequate terrain scale, accuracy, and resolution. (M)
- Lack of an ability to federate and stimulate operational systems. (M)
- Lack of the ability to easily and rapidly conduct collaborative planning, preparation, execution and assessment for exercise, training, and mission rehearsal events. (O), (T), (L), (P) and (F)
- Lack of common and comprehensive scenario development tool. (M) and (P)
- Lack of a Marine Corps policy for training simulation system Verification, Validation, and Accreditation (VV&A). (D) and (L)
- Lack of MAGTF Collective T&R events. (D), (O), (P) and (L)
- Lack of existing authoritative training support data sources. (T)
- Lack of existing collaborative network policies and/or incomplete policy and procedures for establishing collaborative training and education networks. (T) & (P)
- Lack of a training and education policy for the development of standards-based LVC-TE. (D), (L), (T) and (P)
- Lack of policy and benefits for LVC-TE capabilities for the total force. (D), (O), (L) and (P)
- Lack of collaborative networks, with adequate Quality of Service (QoS) characteristics to support collaborative training and education environments. (M)

- Lack of MLS that prevents systems from obtaining access to existing networks. (M) and (P)

- Lack of established Information Assurance (IA) Certification and Accreditation (C&A), and requirements that prevents systems from obtaining access to existing networks for simulations and simulators. (O), (L)

The extent of these gaps presents a clear picture that LVC-TE will have an impact across the Marine Corps—from junior to senior Marines, from individuals to MEFs, from entry level schoolhouses to professional military education, and from forming units to deployed units. This information alone is not substantial enough to secure the necessary resources and institutional will in order to mitigate or eliminate these gaps—a clear demand signal is necessary as well.

4. LVC-TE Demand Signal

Marines rarely take action because of internal reasons, in almost all cases, Marines act because of an external pressure. That pressure can come from a superior, an operations order, doctrine or policy, more funding, less funding, peers, the enemy, media, or subordinates just to name a few sources. This pressure is often deemed a "demand signal" and it has been a recently increasing demand signal for LVC-TE that has allowed concepts from 2010 and before to finally start generating into capabilities with increased levels of resources.

a. I MEF

In 2013, dissatisfied with the Marine Corps' pace of LVC-TE development, the CG of I MEF reached out to PM TRASYS for technical assistance to more quickly develop internal LVC capabilities. His vision and intent (shown in Figure 5) was presented at the I MEF LVC Problem Framing and Observations brief (I MEF, 2013). From December 2013 to August 2014, PM TRASYS (with numerous other stakeholders) proceeded to support I MEF's goals (presented in Chapter III). Most importantly, this demand signal from CG I MEF allowed for additional resources to be applied to LVC-TE

both for the purpose of re-igniting program documentation (i.e. CONOPS, architecture, and the Capabilities Development Document (CDD)) efforts and funds to support I MEF related efforts.

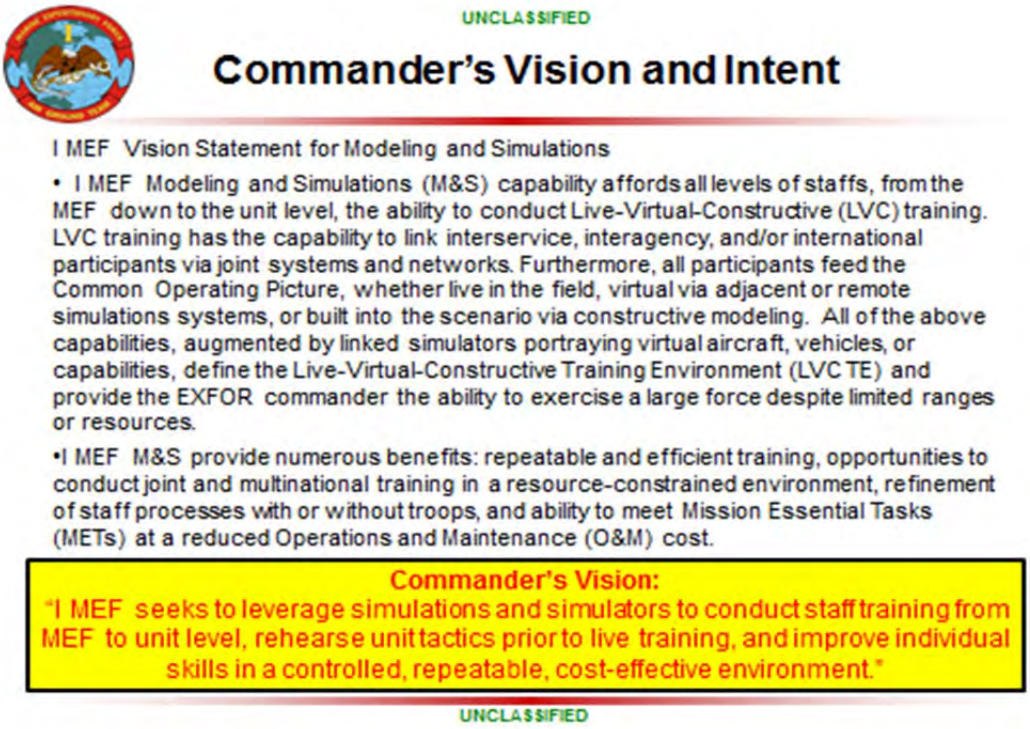

Figure 5. I MEF Commander's LVC vision (from I MEF, 2013)

b. II and III MEF

In conjunction with I MEF's direct demand signal for LVC capabilities, the other MEFs and Marine Forces provided a demand signal with regards to stand-alone training systems capabilities. The other two MEFs, II MEF and III MEF, have provided a demand signal as well. Figure 6 presents some of II MEF's desire per their response to the LVC-TE CONOPS tasker (discussed in Paragraph I.C) and Figure 7 is from a III MEF presentation to TECOM regarding their focus on distributed capabilities (TECOM, 2014a) (III MEF, 2013).

II MEF response to LVC-TE CONOPS tasker

- In training the 2d MEB staff it is useful to train in a live environment to expose the audience to the rigors of live action, weather, deck cycle, etc. However, ***it is very difficult if not impossible to create in a totally live environment the sophisticated scenario and feedback from tactical actions that are essential to meeting MEB training and exercise objectives.*** Complex battlefield functions or processes such as intelligence collection plans, BDA, nuanced MSEL inputs such as IED or IO forensics and feedback are almost impossible to replicate totally live environment. Currently gaps exist between live processes and doctrine, and simulated forces, intelligence, and fires feedback. We ***need the ability to seamlessly create the right sized force with the appropriate assets to meet the mission and training requirements.*** At the higher staff levels this will almost certainly be primarily constructive forces integrated with live forces where appropriate. The fusion of these assets must be transparent to the training audience with no complicated "work-arounds" resulting in the designated training outcome. The ***LVC-TE integration would be critical to the MEB and ESG in meeting their training objectives.***

Figure 6. II MEF LVC-TE Demand Signal (from TECOM, 2014)

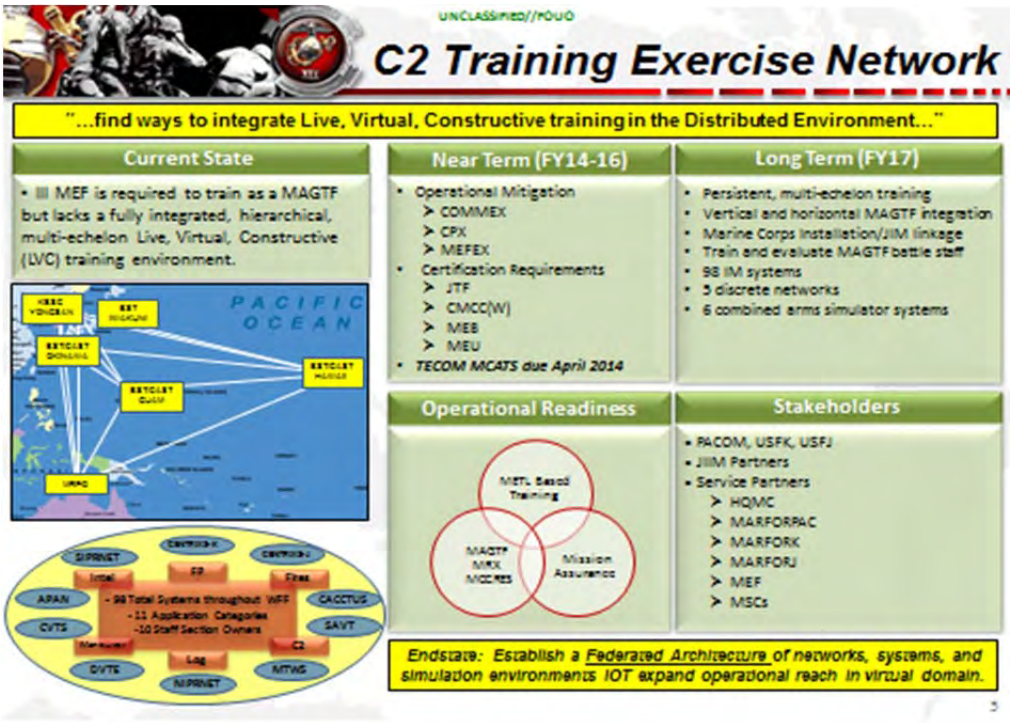

Figure 7. III MEF LVC-TE Demand Signal (from III MEF, 2013)

All three MEFs have different forces assigned, different areas of operation (AO), and different mission priorities, so one of the continual challenges is in providing these three distinct MEFs with a common capability that supports them all well.

c. Enduring Collective Training Requirement

With budgets being cut across all funding lines, operations and management funds for many of the training systems were scheduled to be cut significantly (to $0 in some cases) in Fiscal Year 2014 (FY14). As these training systems provided the capability to fill the gaps caused from reduced funding for some live training, the MEF's and Marine Forces sent a demand signal that funding levels needed to be improved. From October to December 2013 (as shown in Figure 8), the Marine Corps sought to identify which systems had the greatest priority and how much funding was enough to meet MEF and MARFOR requirements. This meant that a subject (training systems), that had previously been obscure from many conversations, was now receiving the attention of 3-star general officers. Deemed the Enduring Collective Training Requirements Working Group (WG), the expressed purpose was to "ENSURE [OPERATING FORCE] REQUIREMENTS FOR SIMULATIONS AND TRAINING DEVICES ARE IDENTIFIED AND DOCUMENTED." (Capabilities Development and Integration (CEAB), 2013). The results provided improved funding for maintaining operational funds for Supporting Arms Virtual Trainer (SAVT) sites and wet egress trainers (simulators for vehicles and helicopters in the water) plus an increase in contractors for simulation services that support major exercises and MEF training (TECOM, 2014b).

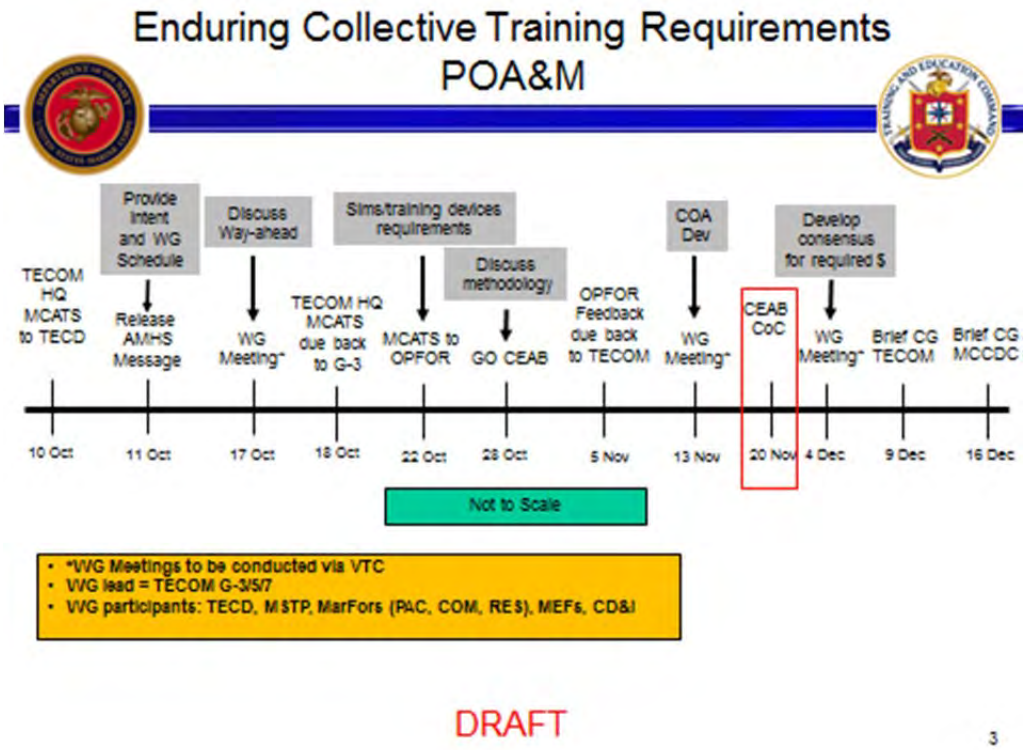

Figure 8. Enduring Collective Training Requirements timeline (from CEAB, 2013)

d. Government Accountability Office

In an August 2013 Government Accountability Office report (GAO-13–698), the GAO acknowledged that the Army and Marine Corps have increased their use of simulators and computer-based simulations over the past decades but concluded that both services lack the ability to make fully informed decisions about whether training requirements can be met with live and simulation-based training. In essence, this report provided an effective demand signal from the Federal Government that training systems are important enough for the services to invest more resources into but that the investment needs to be more systematically executed. Specifically, the GAO recommended two actions: 1) develop outcome-oriented performance metrics that can be used to assess the impact of simulation-based training on improving the performance or proficiency of service members and units, and 2) develop a methodology—to include identifying the costs that should be included and how these costs should be captured—for comparing the costs associated with the use of live and simulation-based training (GAO,

2013). In response to this report, the Marine Corps initiated a two-year study in December 2013 to assess what the "right size" is for training systems in the Marine Corps (Capabilities Development and Integration (OAD), 2013).

5. Current LVC-TE Vision

There are current vision statements and products for LVC-TE. Initially provided as part of a LVC-TE in progress review to CG TECOM in September 2013, Figure 9 provides a view of current Marine Corps training systems and their linkages and Figure 10 provides a view of desired linkages. Figure 11 demonstrates a concept for how LVC-TE capabilities will support the Marine Corps training continuum (TECD, 2014).

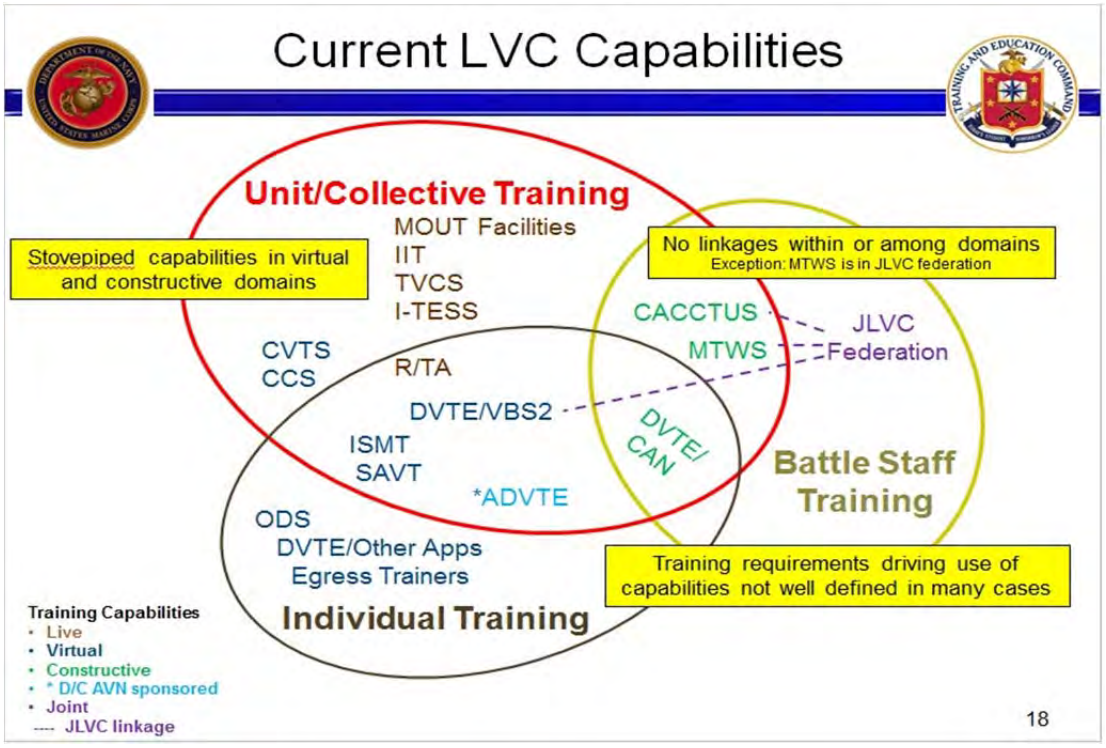

Figure 9. Current view of USMC LVC Capabilities (from TECD, 2014)

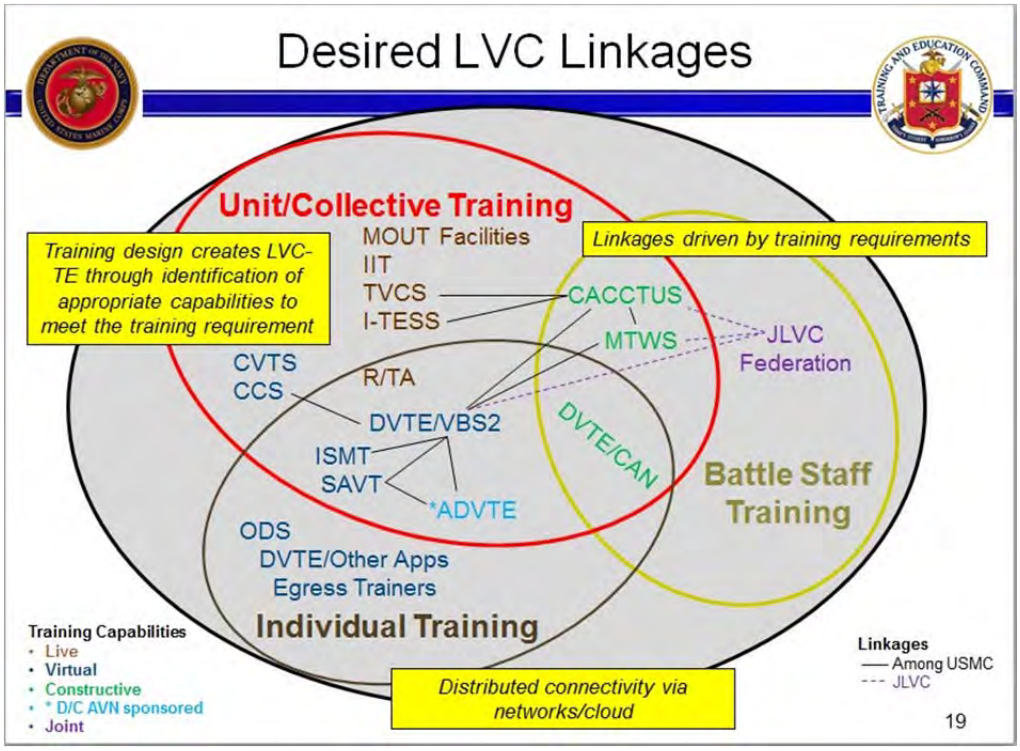

Figure 10. Desired USMC LVC linkages (from TECD, 2014)

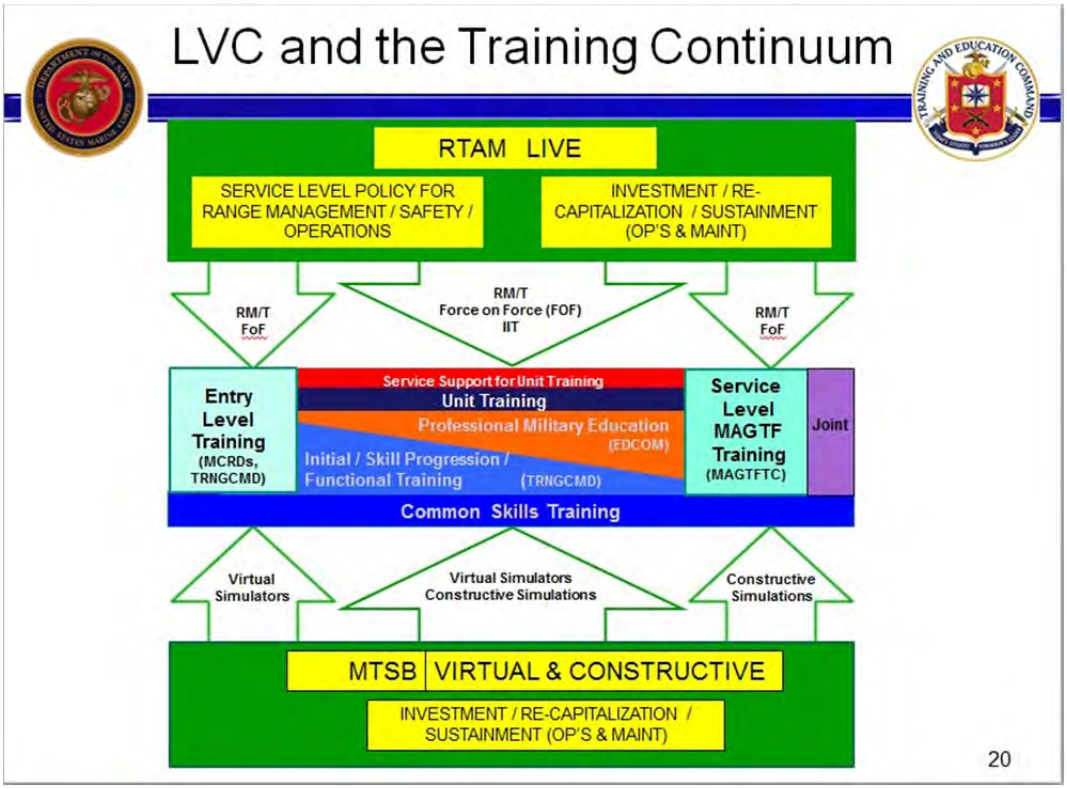

Figure 11. LVC application across Training Continuum (from TECD, 2014)

These figures are available on the TECD website along with the vision statement below:

> "The Live, Virtual and Constructive-Training Environment (LVC-TE) is envisioned as a transformational capability that will federate diverse training and exercise programs to meet individual, unit, and collective warfighting requirements to maintain relevancy, agility, and adaptability. The Marines' long-established adaptability includes a capacity to learn on the job, based on a unique expeditionary mindset that will become an even more valuable asset in the years ahead, especially as the service adapts and builds on its historic role as the nation's crisis response force capable of operating in diverse environments, including those requiring forcible entry." (TECD, 2014)

Additionally, the LVC-TE CONOPS has a vision statement as well:

> "The Marine Corps endeavors to optimize the Corps' Operating Forces, support and sustainment base, and unique capabilities to respond to the complex spectrum of crises, conflicts, and expeditionary operations in urban littorals. In reality, most crises will occur unexpectedly and with minimal warning. Therefore, the MAGTF must have an expanding range of operational and tactical options. It is envisioned that by utilizing LVC-TE, the capability to leverage existing training organizations, technologies, and facilities to optimize and expand those options will be realized. The Battle Simulation Centers, Combined Arms Staff Trainers, Training Support Centers, etc., will play a vital role in ensuring units understand and capitalize on the benefits that LVC-TE training provides. Further, there will be potential savings in time, money and increased efficiency." (TECOM, 2014a)

Though pictures should often tell a thousand words, these products and statements unfortunately fall short of providing a vision that properly accounts for all of the institutional gaps and do not provide bold and far-reaching objectives for the Marine Corps to achieve.

6. Current LVC-TE Strategy?

I am hesitant to say that it is the LVC-TE strategy but it is important to acknowledge that LVC-TE has been properly addressed in TECOM's campaign plans. It is also important because issues that have been highlighted in the past remain relevant issues today because no one from the TECOM or higher level has been addressing those

issues. In order to highlight this, the following information is provided from Appendix A of the Training and Education Command Campaign Plan 2011–2016 (TECOM, 2011).

a. Objective T3. Increase organizational efficiencies by systematically improving and institutionalizing core processes…

b. Initiative T.3.d Implement policies, orders, and directives to govern the integration of a L-V-C learning environment

(1) Who will plan and carry out this Initiative?

- –Lead responsibility: TBD
- Participation/support from: G-3, MTSD, MSTP, TCOM, MAGTF-TC,

(2) When will it be implemented?

- – FY12 Development Phase
- – FY13–16 Implementation Phase

(3) Dependent Initiatives - for which coordination is needed:

- PR1a. Execute a MAGTF Training Program
- PR1b. Develop and implement a MAGTF T&R in accordance with T&R Manual to serve as the capstone T&R Manual
- PR1d. Plan and facilitate a MEU PTP
- PR3a.Provide students with a world-class university
- T1e. Plan infrastructure in support of an integrated L-V-C learning environment
- T3e. Plan for training and education centers at all major installations
- T2a. Develop a network capability to integrate diverse training and education programs
- T3b Develop, implement, and assess core processes
- T1f. Design, Develop, Deliver, Distance Learning solutions and programs

- PR2a. Implement a MAGTF Command Element T&R Program and sustain Ground and Aviation T&R Programs for individual skill progression and resource identification

- T1a. Improve and sustain simulations, simulators, instrumented systems, and automated ranges to enable more effective and efficient individual and collective training and education

(4) Implementation Steps for this Initiative:

- Analyze current L-V-C-TE and DL applications

- Survey of existing level of integration across the L-V-C-TE and DL domains, identify gaps, redundancies, overlaps

- Analysis of efficiencies derived/implied

- Analysis of present costs

- Identify potential areas of future integration

- Perform cost-benefit analysis for enhanced integration

- Develop and promulgate policy within the T&E enterprise

- Market integration activities to operational forces for integration into individual/collective training execution

- Implement the MAGTF-TP Order

(5) Potential Barriers to Implementing this Initiative:

- Organizational resistance to moving away from traditional approaches to training certain skills (ex. preferences for live tank gunnery, CAX etc.)

- Funding to baseline enabling architecture (Opfunds, MILCON, conservative fiscal environment)

- Allocation/programming of sustainment funding

While not as all-inclusive of a strategy as is needed for LVC-TE, these elements do a good job of identifying many of the intricacies and institutional barriers that exist. The one item that is missing within the above list that is still currently missing for the Marine Corps is someone to serve as the lead for LVC-TE implementation. Noted as

TBD (to be determined) in the TECOM Campaign Plan, this function remains a gap and will likely not be properly addressed until a CIO is assigned.

C. LVC-TE INSTITUTIONAL GAPS

Throughout early 2014, TECD worked through the Marine Corps Action Tracking System (MCATS) to develop the LVC-TE CONOPS. This CONOPS was developed with input from commands and organizations throughout the Marine Corps and provides a concept for the application of LVC-TE but this concept is narrowly focused and that actuality continues to highlight the Marine Corps' institutional gaps. The LVC-TE ICD states that it is focused on addressing the materiel gaps of the DOTMLPF analysis and the CONOPS is narrowly focused because it captures near-term capability needs and continues to ignore long-term capabilities. With the incredibly fast cycle at which the world's technology (hardware and software) changes, the Marine Corps cannot succeed with planning that is only focused on near-term capability needs. Before laying out a long-term vision and strategy for LVC-TE, I want to first highlight what those key DOTMLPF gaps are that need to be addressed through integrated planning.

1. Materiel and Facilities

While there are costs necessary to achieve materiel and facility capabilities under LVC-TE, the majority of those costs are currently accounted for in the Future Years Defense Plan (FYDP). Through the FYDP process, the services identify the programs and associated funding that they need in order to be ready and to accomplish the mission. Figure 12 provides the past and current financial outlook for PM TRASYS with respect

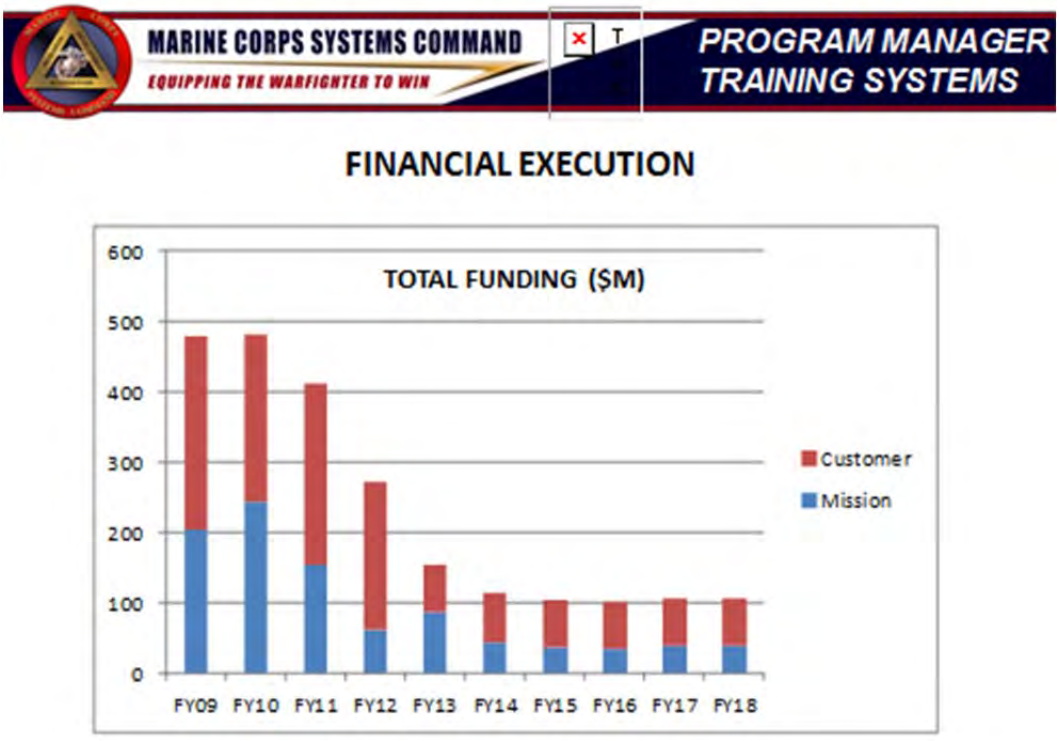

Figure 12. PM TRASYS FY09-FY18 Funding Plan (from PM TRASYS, 2014b)

to the FYDP. Funding was much higher in recent years in order to provide new systems and support high-cost programs like ethnic role-players for deploying units. The funding in FY14 and beyond looks insufficient in comparison but the reality is that this planned funding is focused on sustaining and upgrading those current training systems that are already fielded. Though LVC-TE is not currently established as a separate program with its own funding, the Marine Corps does know that near-term LVC-TE capabilities can be achieved through modifications to current C4I and stand-alone training systems that are established programs with funding (demonstrated at LSE-14). Those C4I and training systems though do not have written requirements to work with in order to achieve near-term LVC-TE capabilities. This means that those program offices are executing current requirements that may be archaic compared to LVC-TE requirements or that may delay the opportunity to institute LVC-TE capabilities. The same goes for current plans for modifications to facilities or new military construction. Current facility plans were

developed prior to the LVC-TE CONOPS development and certainly without a long-term LVC-TE vision and strategy in place. With this disconnection, how does the Marine Corps expect to ensure that LVC-TE does not suffer in later years because of poorly planned infrastructure capabilities? This question, and many others, exists because the Marine Corps does not have prioritized LVC-TE requirements against the FYDP and is not following a process to ensure that requirements are integrated and synchronized across training systems, C4I systems, ships, and military construction.

2. Training, Leadership and Education

In order to develop and employ LVC-TE's robust capabilities, the Marine Corps, particularly mid-level and senior leadership, must become inculcated with LVC-TE. The Marine Corps can institutionally achieve this through training and education (T&E) but a cultural gap exists here more so than a capability gap. Though the Marine Corps has an increased number of training systems available to support training from the individual to MEF level, it is a small number of Marines who routinely utilize these systems as demonstrated by annual usage data provided to PM TRASYS (see Appendix A). Most new users appear to seemingly stumble upon the training systems by happenstance, not by design. Even with a sharp decrease in the number of Marines deployed to Afghanistan, the operational tempo for units has not decreased enough for leaders to feel they have the time and space to properly crawl, walk, and run through their T&R requirements (often called pre-deployment training). When Marines are pressed for time, they react with muscle memory. This means that they rely on what they already know and the vast majority does not know about training systems and LVC-TE. There are three reasons for this.

a. Absence from Education

The Marine Corps does not include training systems and LVC-TE as part of its education focus. Though some schoolhouses do support portions of their curriculum with training systems, there is no structured education on the systems, their capabilities, and the LVC-TE concept.

b. Absence from Training Courses

The Marine Corps does not train its Marines to use training systems, to use LVC-TE, or how to incorporate them into unit training plans.

c. Absence from T&R Standards

The Marine Corps does not prescribe the use of training systems and LVC-TE. Except in the case of resource exhaustive communities like aviation, armor, assault amphibians, light armored reconnaissance, and motor transportation, the Marine Corps does not have T&R standards that prescribe the use of these capabilities. The Marine Corps has a propensity to let commanders decide for themselves how to achieve their T&R requirements. This means that those commanders and their Marines will not use training systems (and a LVC-TE concept) that they have not been educated on, trained to use, or prescribed to use. A lack of policies with regards to T&E efforts has likely stunted the Marine Corps' institutional growth and recent promising LVC-TE achievements may be for naught without T&E being addressed from the top down.

3. Integration

As extensive as LVC-TE clearly is, there is no one serving as the LVC-TE capabilities integration officer (CIO). The capabilities developed to this point have been based on small groups of personnel and organizations coming together sporadically to achieve common LVC training objectives. There is not an individual or organization that is *the lead* for integrating LVC-TE into EF-21 or other concepts and capabilities. Figure 13 provides a schematic that I developed in order to explain the requirements flow to PM TRASYS. LVC-TE is an enterprise problem but it is regularly rendered a "TECOM problem" and this mislabeling has left LVC-TE out of normal capability development and integration efforts that take place *above* TECOM. This has meant a lack of unity of command, which means there is no true unity of effort for LVC-TE integration.

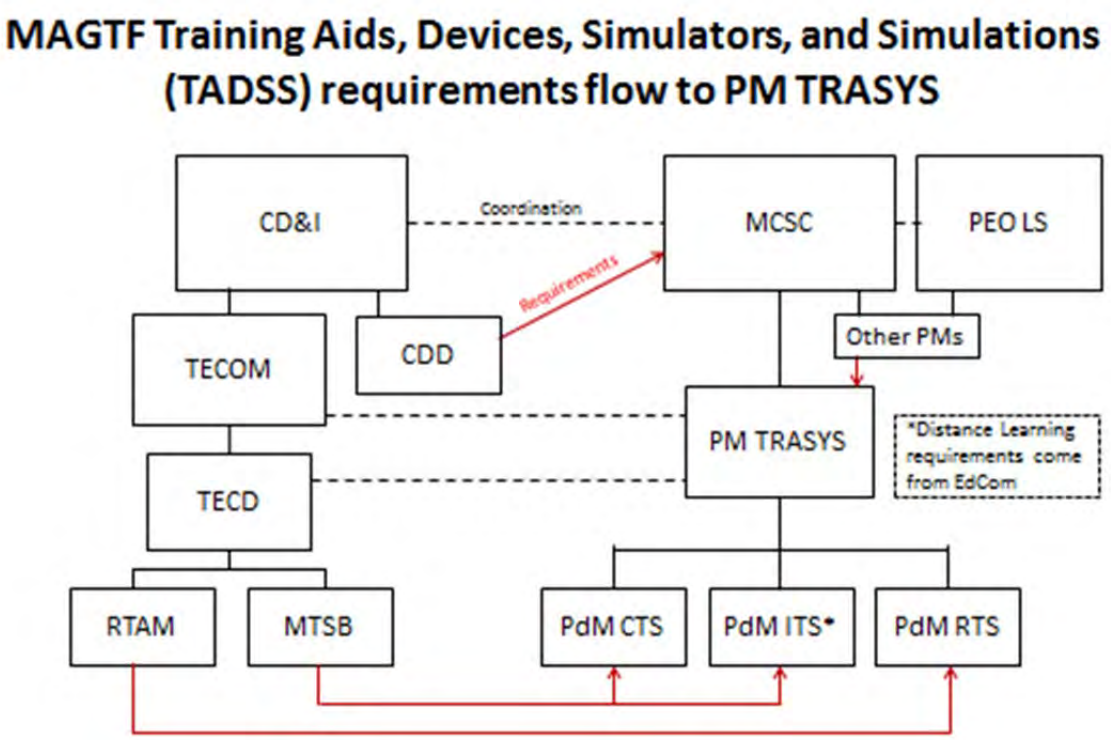

Figure 13. Flow of requirements to PM TRASYS

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II. EVOLUTION OF IDENTIFYING THE PROBLEM

A. PROJECT MANAGER—COMBINED ARMS COMMAND AND CONTROL TRAINING UPGRADE SYSTEM (CACCTUS)

1. Introduction to Project Management for Training Systems

In January 2012, while assigned to PM TRASYS, I was very unexpectedly assigned duties as the project manager (PJM) for CACCTUS. This was the first time that I had been assigned at the project level and worked directly with an integrated product team (IPT). While it was under unfortunate circumstances (the serious injury of a colleague) it was extremely important in allowing me to begin understanding the environment and institutional challenges for training systems and LVC-TE.

The aspects of CACCTUS itself are not important to this paper but the lessons learned resonate across other training system programs and LVC-TE. One of the striking items that I learned early on was that there was only one other uniformed Marine directly involved with CACCTUS management and development. All other personnel that I dealt with were either government civilians or contracted civilians. This fact concerned me because I was not sure if I knew what Marines needed from CACCTUS if I was not able to directly hear from them.

2. Developing an Integrated Plan

I had a tremendous amount to learn after becoming a PJM and compensated for my acquisition shortfalls by focusing on what I knew how to do as a Marine. That meant identifying my mission and then developing a plan to achieve the mission. After pouring over a number of recent and historic documents for CACCTUS, I was able to clarify that my mission was to achieve full operational capability (FOC) for CACCTUS in early FY18 (initial operational capability had already been achieved). That meant that I had roughly five years to achieve FOC requirements but I did not expressly know what those requirements were or what order they needed to be completed in. Working primarily with the engineers and logistician on my IPT, we identified broadly stated hardware and software capabilities that we felt were needed and then we made sure that they lined up

with the CACCTUS CDD. This initial plan for achieving FOC is provided in Appendix B. We evaluated which capabilities we thought were higher priorities for training, which ones were needed in order to enable other capabilities, and which ones needed more time for technological maturity. Though not provided in this paper, we made rough order estimates of costs for those capabilities in order to see how they lined up with our planned funding in the FYDP. Following my IPT's efforts, we presented this plan to a Users' Conference with representatives (all civilians) from the five locations across the Marine Corps. The results of that gathering are presented in Appendix C. Some requirements received new prioritization, others were found to be redundant or unnecessary, and we learned that some requirements were be developed by other programs that we could wait to borrow. This collaborative process allowed us to write better task orders to our prime contractor, develop better training instructions, adjust hardware requirements, and validate or request adjustments to the FYDP—we were able to immediately reallocate $1 million to another program within PM TRASYS after looking at our immediate requirements versus funds available.

3. Where Is My Advocate?

While very fruitful and very educational, I remained concerned that we had developed this detailed and comprehensive plan without any other uniformed Marines present and without any other program offices or CIOs. I knew that our plan supported the CACCTUS CDD requirements (approved in December 2008) but how did I know if our plan lined up with other Marine Corps requirements and capabilities? At the time of our conference in August 2012, LVC-TE was not a blip on my radar as a project manager. Why did I not have instructions and guidance related to ensuring that the plans for CACCTUS were in line with future LVC-TE requirements and capabilities? Most of all, I asked where my advocate was.

B. WHAT IS ADVOCACY?

Despite written policies and processes, Marine Corps training systems have lacked sufficient advocacy in past years. The absence of sufficient advocacy can lead to misrepresentation of system requirements and inaccurate prioritization of funding

requirements—the total result being that Marines are not provided the training systems and LVC-TE capabilities that they actually need in a timely manner. Advocacy has become such an important element for Marine Corps business that new a Marine Corps Order (MCO) was developed and signed in 2013. The specified end state of this MCO is that "Advocates make recommendations in their areas of expertise to support well informed decisions. Advocates and proponents represent the Marine Corps position on their areas to organizations outside and inside of the Marine Corps" (CMC, 2013). There are quite a number of functional areas identified in the MCO but the focus is on ensuring that the MAGTF elements and Marine Corps warfighting functions are fully covered. The MCO specifically identifies the unique and broad advocacy roles that Capabilities Development and Integration (CD&I); Plans, Policies, and Operations (PP&O); and Installations and Logistics (I&L) have in the total process. Without fully reciting the MCO, the best way to demonstrate the totality, complexity, impact, and importance of advocacy is to look at how PP&O and I&L view their roles. Figure 14 is PP&O's view on advocacy as specific to the GCE and Figure 15 is I&L's advocacy concept with a focus

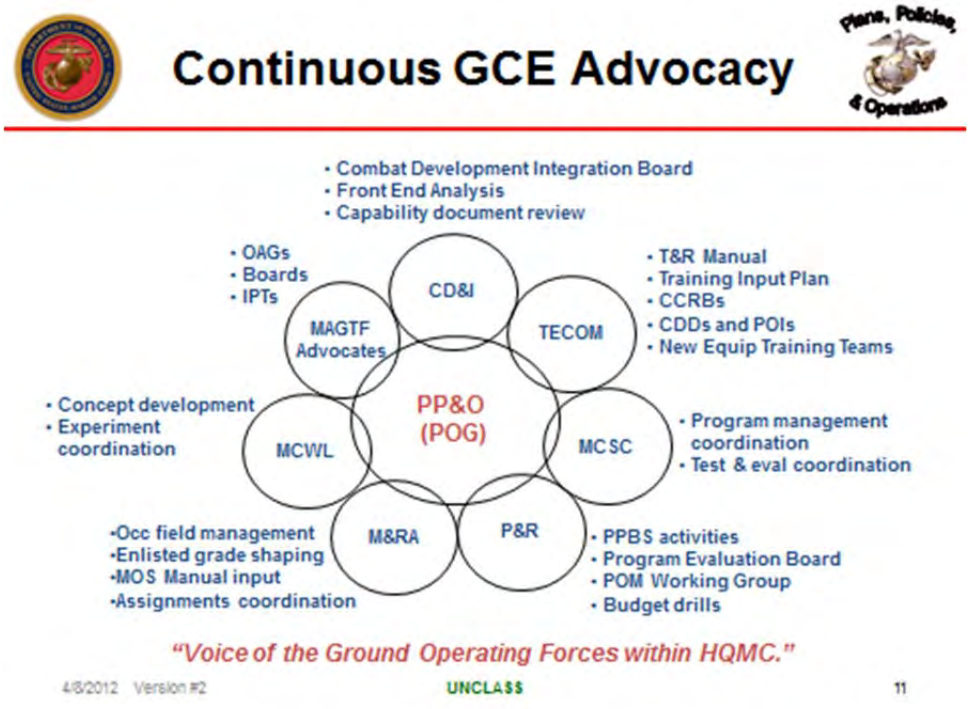

Figure 14. PP&O (GCE advocate) concept for advocacy (from PP&O, 2013)

Figure 15. I&L (LCE advocate) concept for advocacy (from I&L, 2013)

on the LCE. In order to address the issues that matter most, the advocates utilize processes that allow them to hear and present the issues, socialize them, prioritize them, and then present them for decisions as necessary at the appropriate levels. The following are a number of those processes used as necessary to support both program development and then advocacy (PP&O, 2013) (I&L, 2013).

1. PROCESSES

a. Configuration Control Boards/Integrated Product Teams

Configuration Control Boards (CCB) and IPTs are the lowest level of the process. IPTs, sometimes just a few persons and sometimes dozens, are the teams that manage the day-to-day activities of a project. CCBs are when the IPT members, primarily leadership, meet with other stakeholders, primarily users and requirements officers, to identify changes necessary within the project to make sure it maintains the configuration required to support the users' needs. At least in the case of training systems, CCBs take place at irregular intervals with little knowledge outside of a core group of individuals and often

without uniformed Marine involvement. Though labeled a Users Conference, the meeting in August 2012 was essentially a CCB.

b. Working Groups and Working IPTs

Working groups (WG) and Working IPTs (WIPT) are mid-level leadership meetings that can often involve O-6 and GS-15 level personnel. Their focus and purposes can vary widely but are generally intended to address issues across numerous programs or systems.

c. Operational Advisory Groups

Operational advisory groups (OAG) serve intermediate purposes as the forum in which advocates are able to fully socialize and evaluate issues as envisioned in Figures 14 and 15. MCO 5611.6 specifically states: "OAGs provide a forum for interface between operating forces and Headquarters, Marine Corps and supporting establishment action officers. They normally serve as a vehicle for identifying and recommending prioritization of issues and solutions that directly impact a specific area of operational capability." OAGs are additionally authorized to establish temporary IPTs or WGs as necessary (CMC, 2013). While attended by various personnel throughout the Marine Corps, OAGs typically have a core voting membership of O-5 and O-6 commanders. In terms of the "process," OAGs are essential as they are the forum where issues are identified for further action/decision or not. 1- or 2-star general officers often receive the immediate output of OAGs.

d. Boards

Boards are the senior and highest level for advocacy. They are chaired by the senior advocate (normally a 3-star general officer (GO)). As an example, in the case of the GCE, the Ground Board is chaired by DC, PP&O. MCO 5611.3 defines the Board's role as to "review emerging issues, develop top level consensus, and assist in facilitating engagement and necessary actions." (CMC, 2013) Figure 16 provides a good example of the process and communities involved from the OAG to Board level in the case of the GCE. Often, issues within each MAGTF element can be decided at the Board level but

those issues that have a full Marine Corps impact or cannot be handled by the resources within that advocate are elevated to the MROC.

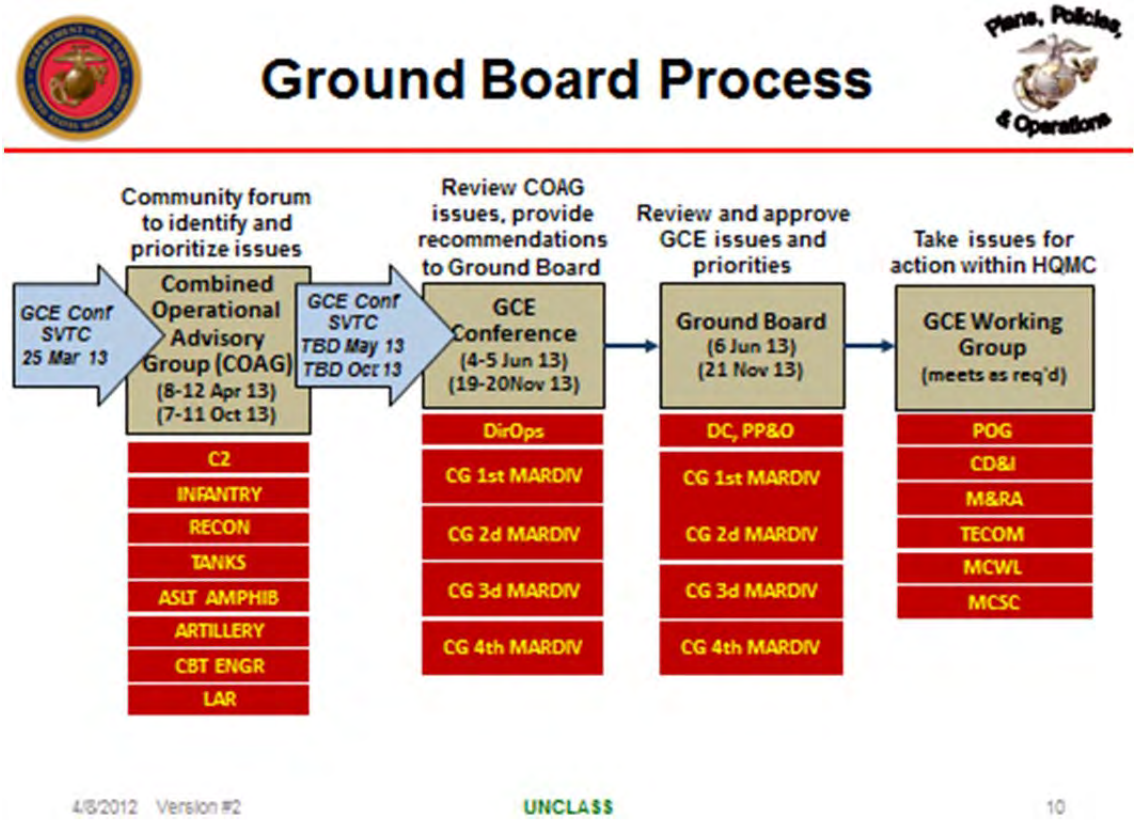

Figure 16. Ground Board Process—GCE Advocate (from PP&O, 2013)

e. MROC

First preceded by the Marine Requirements Board, the MROC is the final stop for official decision making with regard to programs and most issues in the Marine Corps. Items like ICDs and CDDs are approved at the MROC level. The MROC is chaired by the Assistant Commandant of the Marine Corps (ACMC). Figure 17 provides a process flow for issues to flow to and through the MROC (CMC, 2013).

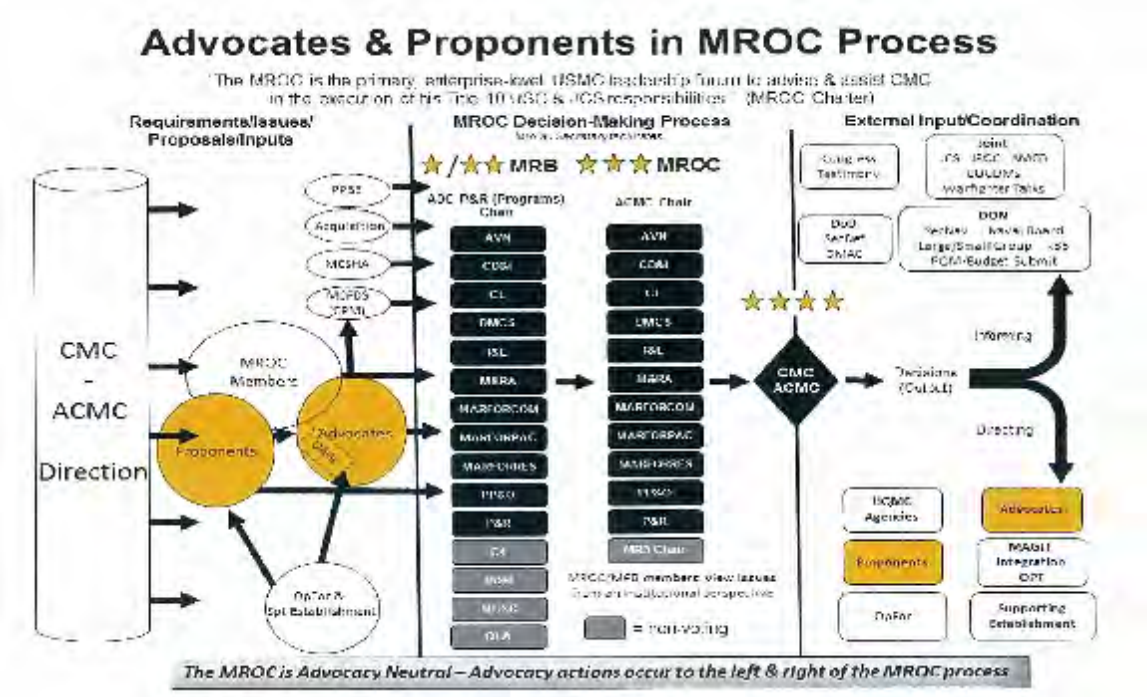

Figure 17. Advocates and Proponents role in MROC Process (from CMC, 2013)

f. Training Systems and LVC-TE Process?

Through examining numerous communities and programs throughout the Marine Corps, one would see that they follow this integrated process in order to achieve issue resolution and top-level guidance. They follow this process through the actions (coordination, planning, briefings, etc.) of the advocate action officers. In the case of training systems and LVC-TE, this is not the case. Though there are established IPTs, CCBs, WGs, WIPTs, OAGs, and Boards that training systems and LVC-TE fall under, there is no central action officer (i.e. CIO) to ensure that they are connected (via issues, personnel, organizations, funding, etc.) to form an integrated process. As such, training system and LVC-TE issues have gone unnoticed without proper socialization, and often without decision makers being involved. As I looked to identify my advocate while I was the CACCTUS PJM, I became very aware that the process was not working for my system or others. So I set about to educate myself and many others about training systems and LVC-TE and seek out an advocate.

C. ROADSHOW FOR EDUCATION AND ADVOCACY

Appendix D provides a comprehensive list of the key briefings, meetings, and conferences that I attended in a little less than 18 months. Every one of these events provided new information and there was very much an evolution of better understanding the Marine Corps through this process. Though I am attempting to separate these activities below, the reality is that they are all interconnected and it must be understood that all of these events are constantly building on one another and usually have overlapping issues, people, and organizations.

a. OAGs

My first OAG interaction was with the GCE Combined OAG (COAG) in April 2013. I had attended the Infantry OAG in a previous billet and knew what to expect as far as people and issues but I was not sure how I would be received coming in from the acquisitions community. Aside from being in acquisitions, my billet in Orlando, Florida with PM TRASYS meant that I rarely had daily contact with the operating forces and headquarters Marine Corps (HQMC) action officers. When I attended the GCE COAG, I saw that other MCSC PMs were very involved in the meetings. This is when I realized that training systems and LVC-TE were not being properly presented at the OAGs because no one knew that they needed to talk about them. I then sought to identify which OAGs were appropriate venues for those topics and to request speaking opportunities. Those key OAGs identified were the GCE COAG, I&L T&E OAG, MAGTF Fires OAG, and MAGTF T&E OAG. Though I did not directly attend any OAGs that fall under the ACE advocate, there were often ACE action officers at the other OAGs; particularly the MAGTF Fires OAG.

b. HQMC Advocates

Though advocate action officers are at the center of organizing and running the OAGs, it is essential to brief them separately in order to gauge the maturity and relevancy of issues. I directly set up meetings and briefings in August and September 2013 with action officers at PP&O (POG), I&L (LPC), and CD&I (Fires and Maneuver Integration Division (ID), Logistics ID, MAGTF ID) in

order to directly ask for assistance in advocacy and opportunities to educate their OAG participants about training systems and LVC-TE. While I was well received and had good conversations, the primary message that I received back was that the issues that I was bringing up were "TECOM issues" and did not necessarily apply to them. This was frustrating yet essential to understanding the problem. If I wanted training systems and LVC-TE to become agenda items at OAGs, then I would need to convince the action officers of this.

c. Conferences

Outside of the advocacy process are numerous conferences. Sometimes they are called symposiums or other names but they are all gatherings for specific communities or events and they all offer additional opportunities to present issues for further socialization and awareness. The most important conferences that I attended, aside from those related to Large Scale Exercise 14 (LSE-14), were the Inspector and Instructor (I&I) Conference held by Marine Corps Forces Reserve and the Senior Gunners Symposium (neither event had published proceedings). The I&I Conference continued to confirm how uneducated and unaware many Marines are with regards to training systems and LVC-TE. Having previously attended the Gunners Symposium and having worked with Gunners (Infantry Weapons Officers) throughout my career, I knew the impact that their community can have within the Marine Corps, particularly the GCE. Through further educating them on training systems and LVC-TE, they later asked for direct training regarding these issues for their new class of Gunners. Some of the results of this training are provided in Chapter IV but this was a very important step in continuing to evolve my own education.

d. Integrating the Processes

Marines respond primarily to external pressures and, in the case of advocate action officers, they respond to the needs of their bosses (Colonel O-6, 1- to 3-star GOs) and the operating forces that they represent. The illustration of this is provided in my success with the Logistics community. I first met with a representative of I&L (LPC) in August 2013. LPC is the advocate for the Logistics community and LPC-3 specifically focuses on T&E. I was able to get on the agenda for their first I&L T&E OAG in

November 2013. While providing a well-received education to the participants, I did not succeed in LPC-3 recognizing the need to become the advocate for any specific training systems and to become more directly involved in LVC-TE. Learning my lessons from that experience, the other experiences, and my continuing education on LVC-TE, I was better prepared to present during the next I&L T&E OAG in May 2014. At the first OAG, I had given a PM TRAYS command brief and overview of all training systems. During this second OAG, I streamlined the topics to just a few systems that I felt directly supported the Logistics community's T&R needs and an overview of LVC-TE. Just prior to the May 2014 OAG, the inputs from across the Marine Corps had just been received in MCATS for the LVC-TE CONOPS. Pulling from those inputs, I was able to provide direct demand signal statements from the four Marine Logistics Groups (one from each MEF and Marine Forces Reserve) in order to present at the OAG. After first explaining and discussing what LVC training is, I then presented a demand signal slide and opened up the issue for further discussion. With formal Logistics schoolhouses jumping in as well, the advocate was able to hear that their operating force and supporting establishment commanders had requirements for these capabilities and they needed training systems to better meet their T&R needs. It was at this time that the LPC advocates acknowledged that they (or someone within I&L) needed to get further involved. This was an essential step forward in both achieving further socialization and awareness of LVC-TE but in also fully realizing how to properly utilize and integrate the various elements of the advocacy process. This success is demonstrated in Figures 18 and 19. The slides in those figures are from the out-brief at the May 2014 I&L T&E OAG and highlight the recognition of simulation and LVC-TE as issues that I&L needs to take further action on (I&L, 2014).

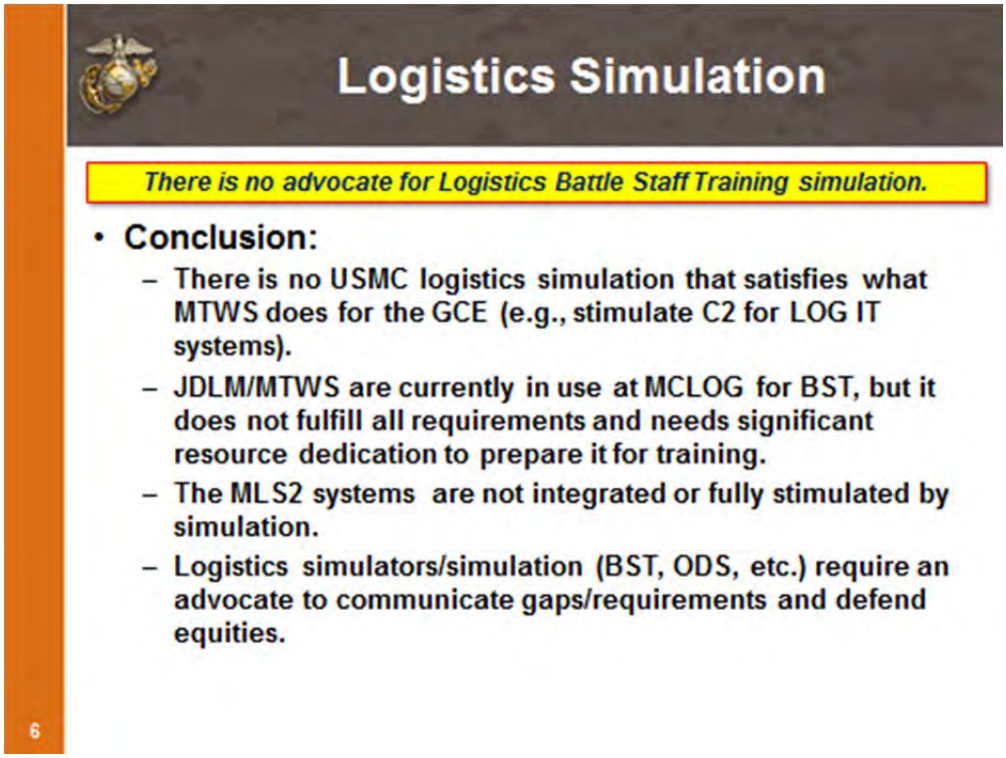

Figure 18. Logistics simulation issues (from I&L, 2014)

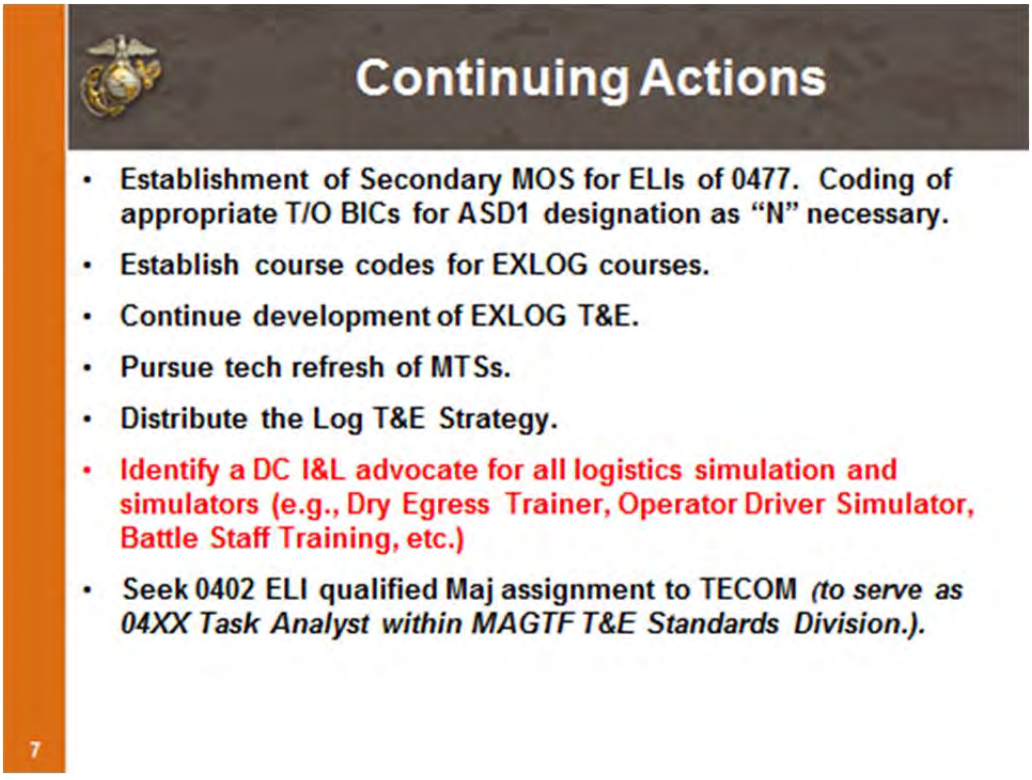

Figure 19. LCE advocate continuing actions (from I&L, 2014)

D. AN UNINFORMED MARINE CORPS

Though some gains have been made in further educating select action officers about LVC-TE, the results remain clear to me that the vast majority of the Marine Corps remain uninformed. With even the minor expectations that TECD has for how much LVC-TE will impact and support the Marine Corps, it is questionable how effective and well received the capabilities will be if Marines are not more involved in the process and educated and trained on how to utilize LVC-TE. Before addressing how to do that, the myriad potential capabilities that LVC-TE can provide need to be understood.

III. IDENTIFYING THE POSSIBILITIES

After turning over my CACCTUS PJM duties in January 2013, I took on a new role within the Operations Section of PM TRASYS. In conjunction with this, I became aware in March 2013 that TECD and TECOM were moving forward on LVC-TE development. I volunteered to be the LVC-TE lead for PM TRASYS. Knowing that there were numerous gaps towards training systems development, I expected to find the same within LVC-TE development. I sought out all opportunities to both educate myself and others on about training systems and LVC-TE. I found that the only way to capture current and future efforts was to actively seek out those individuals and organizations that were specifically engaged in activities with regards to the Navy and Marine Corps.

A. LVC-TE IS NOT A NEW CONCEPT

The Marine Corps has been poised to dramatically move forward in LVC capabilities before–both in terms of concept and initial capabilities. In the September 2002 issue of the Marine Corps Gazette, Dr. Michael Bailey provided a realistic concept of training (CACCTUS and Deployable Virtual Training Environment (DVTE)) and C4I systems being interoperable in order better support mission rehearsal for Marines afloat and ashore yet, 12 years later, the Marine Corps remains unable to fully provide this capability (and not because of technical shortfalls) (Bailey, 2002).

A large part of the Marine Corps' problem with developing LVC-TE has been a failure to immediately follow-up and build upon past efforts. In 2005 and 2007, Marines in 29 Palms California were training virtually with AC-130 pilots in Hurlburt Field, Florida. Utilizing the joint training enterprise network, Marines conducted ground maneuvers in DVTE while also performing forward air controller tasks with the AC-130 pilots that were in their simulators (AFSOC, 2005) (Coslett, 2007). Though similar training has been continued through events like Emerald Warrior, this training is not standardized and has not been a capability that the Marine Corps has institutionally addressed (Velazquez, 2014). Those efforts in 2005, 2007, and since were coordinated and executed locally. While the final objective is for LVC-TE to be readily accessible

and easily support units locally, the Marine Corps cannot achieve that objective when initial LVC efforts are being conducted separately without direct linkage to institutional efforts and resources.

Despite these past disconnections, the Marine Corps is in an encouraging position to realize those LVC concepts that Dr. Bailey and others have introduced in the past. While other LVC integration and interoperability efforts have been within the spirit of LVC-TE, it is only recently that the Marine Corps has taken a giant step to demonstrate the holistic training capabilities that LVC-TE can provide–this was done through LSE-14. What is truly different with regards to LSE-14 is the assimilation of training systems into a large MAGTF exercise in which all levels for coordination and execution were participating and able to train in a connected environment regardless of accessing the training via L, V, or C systems.

B. DEVELOPING NEW CAPABILITIES, AGAIN

PM TRASYS heard of I MEF's desire to integrate virtual training systems in the Fall of 2013 and recognized that it was an objective that the operating forces should not be trying to achieve alone. At the same time, the Assistant Wing Commander, 3d Marine Air Wing had directly reached out to Deputy Commander; Systems Engineering, Interoperability, Architectures and Technology (SIAT). This is when MCSC support to I MEF began to develop. Leveraging the right attendance of individuals at the Interservice/Industry Training, Simulation and Education Conference (I/ITSEC) in early December 2013; I MEF, PM TRASYS, Naval Air Warfare Center Training Systems Division (NAWCTSD), SIAT, and TECD began a partnership to improve current simulation interoperability capabilities. Realizing the advantage that LVC can provide his units for both home station training and exercises like LSE-14, CG I MEF contacted PM TRASYS that same week of I/ITSEC to officially ask for support in conduct of a proof of concept (PoC) in late January 2014 (see Figure 20). The concept was a success with all four goals (bottom-left corner of Figure 20) being achieved. It was during the development of the PoC that Marine Corps Tactical Systems Support Activity (MCTSSA) became fully involved as well. Shortly after the PoC, an LVC WG met in Orlando, Florida in order to develop a supportable simulation capability for inclusion into

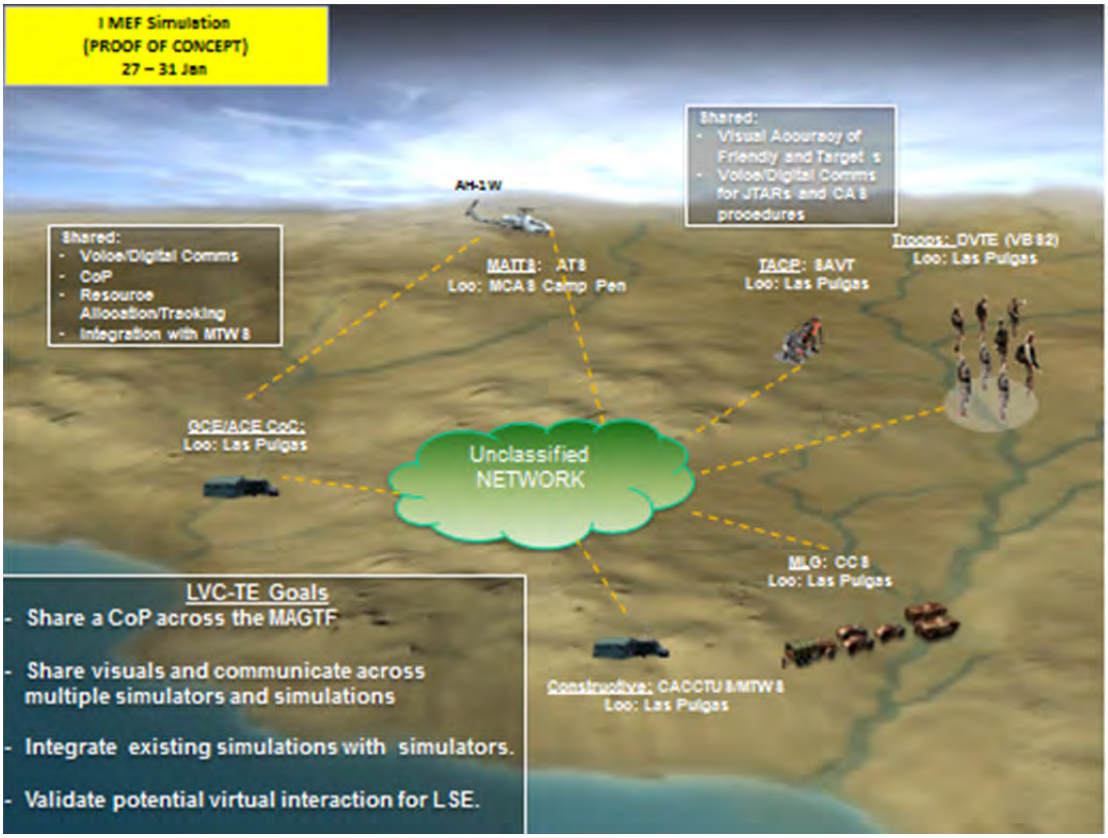

Figure 20. Operational View for I MEF LVC Proof of Concept. (from I MEF, 2014)

LSE-14. At this stage, the LSE-14 Concept Development Conference and Initial Planning Conference (IPC) had already been conducted, so there was limited opportunity to get a complete LVC concept included into LSE-14. Working in a very short amount of time with a large number of PM TRASYS and NAWCTSD engineers, a technically supportable simulation capability was developed that would allow for unclassified virtual simulators to simultaneously interact while sending "tracks" to the classified common operating picture (COP) (see Figure 21). This capability was briefed at the LSE-14 Mid-Planning Conference (MPC) in February 2014 and was accepted under the condition that it would "do no harm" to the exercise network and would not interfere with the primary training audience (1st MEB, 2014). In the ensuing months, the numerous stakeholders (see Figure 22) continued frequent collaboration that included on-site laboratory integration in Orlando in June 2014. In addition, I MEF worked closely with

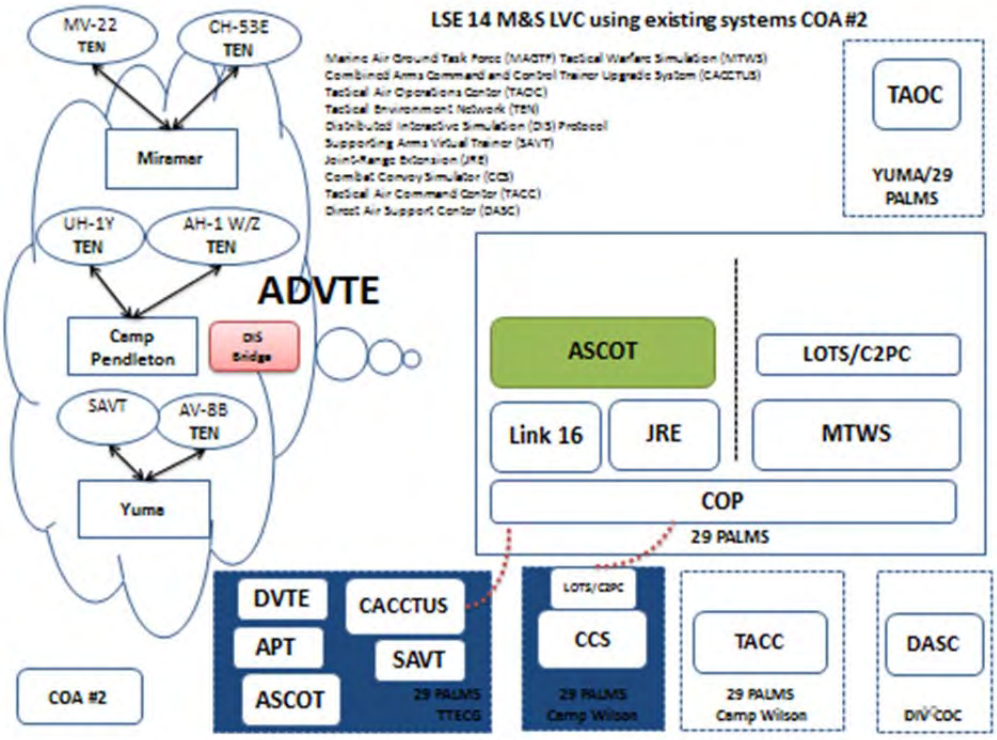

Figure 21. LSE-14 LVC Integration Concept (NAWCTSD, 2014)

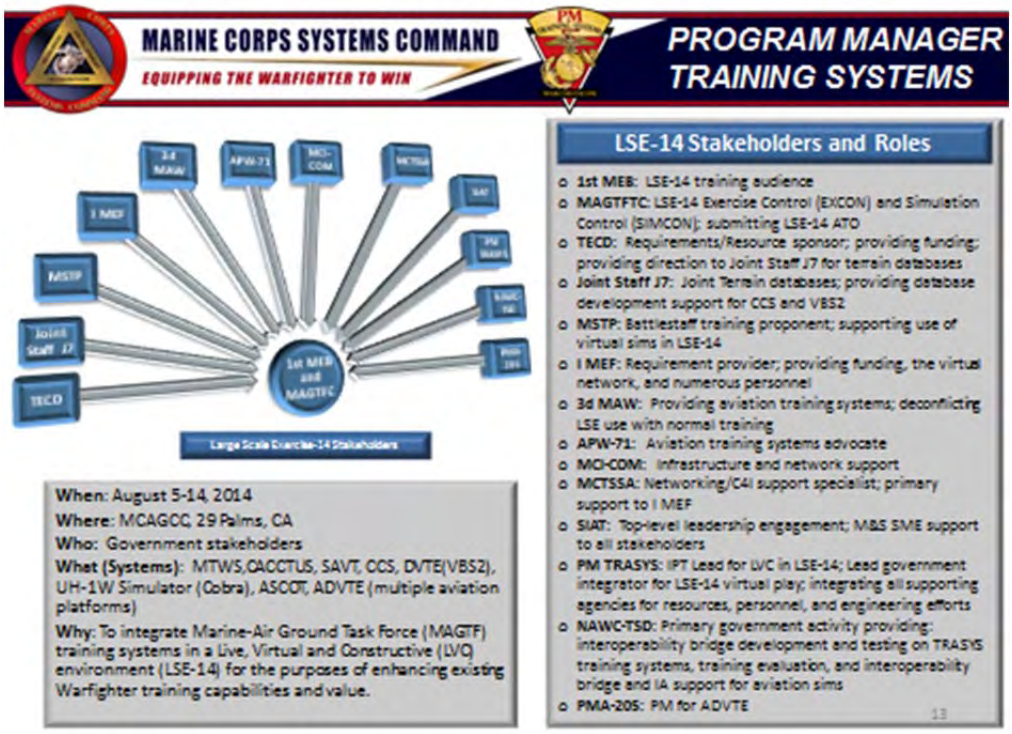

Figure 22. LSE-14 Stakeholders for LVC (from Author, 2014)

NAWCTSD and the Deputy Commandant for Aviation (APW-71) to integrate the Aviation Distributed Virtual Training Environment (ADVTE) into the classified network for LSE-14.

C. LVC-TE CURRENT CAPABILITIES

The Marine Corps' most robust set of current capabilities were demonstrated during LSE-14 in August 2014. Though the LVC-TE efforts were limited in scope compared to the size of the overall exercise, virtual integration did support MAGTF training by linking individual training up to the MEB staff's training. Utilizing LVC, 1st MEB executed LSE-14 with more than 3,700 live Marines and Sailors while the other members of the 15,000-person MAGTF were simulated virtually and constructively (Kovach, 2014). The 5th Canadian Mechanized Brigade Group (CMBG) additionally participated as an adjacent unit to 1st MEB. 5th CMBG's roughly 100 personnel provided a live combat operations center (COC) while the rest of their forces were constructive (Mundy, 2014). Whether coming from immersive trainers (e.g., aviation training systems (ATS), SAVT), computer based trainers (e.g. DVTE, MAGTF Tactical Warfare Simulation (MTWS)), or C4I systems (e.g. Command and Control Personal Computer (C2PC), Blue Force Tracker (BFT), AN/TPS-59 radar), the MEB and its MSCs were able to simultaneously track the locations of all participants via their top COP and communicated up, down, and laterally across the organization.

1. Overview of Large Scale Exercise-14 (LSE-14)

LSE-14 was an assessed MAGTF exercise at the MEB level composed of all four elements of the MAGTF. The CE was 1st MEB, GCE was Regimental Landing Team-7 (RLT-7), ACE was Marine Air Group-16 (MAG-16), and LCE was Combat Logistics Regiment-1 (CLR-1). The live maneuver elements and combat operation centers (COC) were located at the Marine Corps Air-Ground Combat Center (MCAGCC) at 29 Palms, California but LSE-14 was conducted in a distributed and near simultaneous manner across several installations which also included Marine Corps Base Quantico, Nellis Air Force Base (AFB), Marine Corps Air Station (MCAS) Yuma, MCAS Miramar, and MCAS Camp Pendleton), which demonstrates the MAGTF's core capabilities within a

joint and combined operating environment with appropriate exercise control and training. Figure 23 provides a view of the MEB table of organization for LSE-14 (live elements are in "blue" and constructive are in "gold"). Though many of the units were "live," they may have only been represented in the training area by a COC and key personnel (e.g., fire support coordination centers and fire support teams); this is why a 15,000-person MEB was in reality only upwards of 4,000 actual participants. The Air Force was integrated as well with the Combined Air Operations Center at Nellis AFB. MAGTF Training Command (MAGTFTC) was the overall Exercise Lead for LSE-14 with MAGTF Staff Training Program (MSTP) providing Exercise Control. 1st MEB and 5th CMBG reported to Combined Forces Land Component Commander (CFLCC); the CFLCC was located in Quantico, Virginia at MSTP facilities.

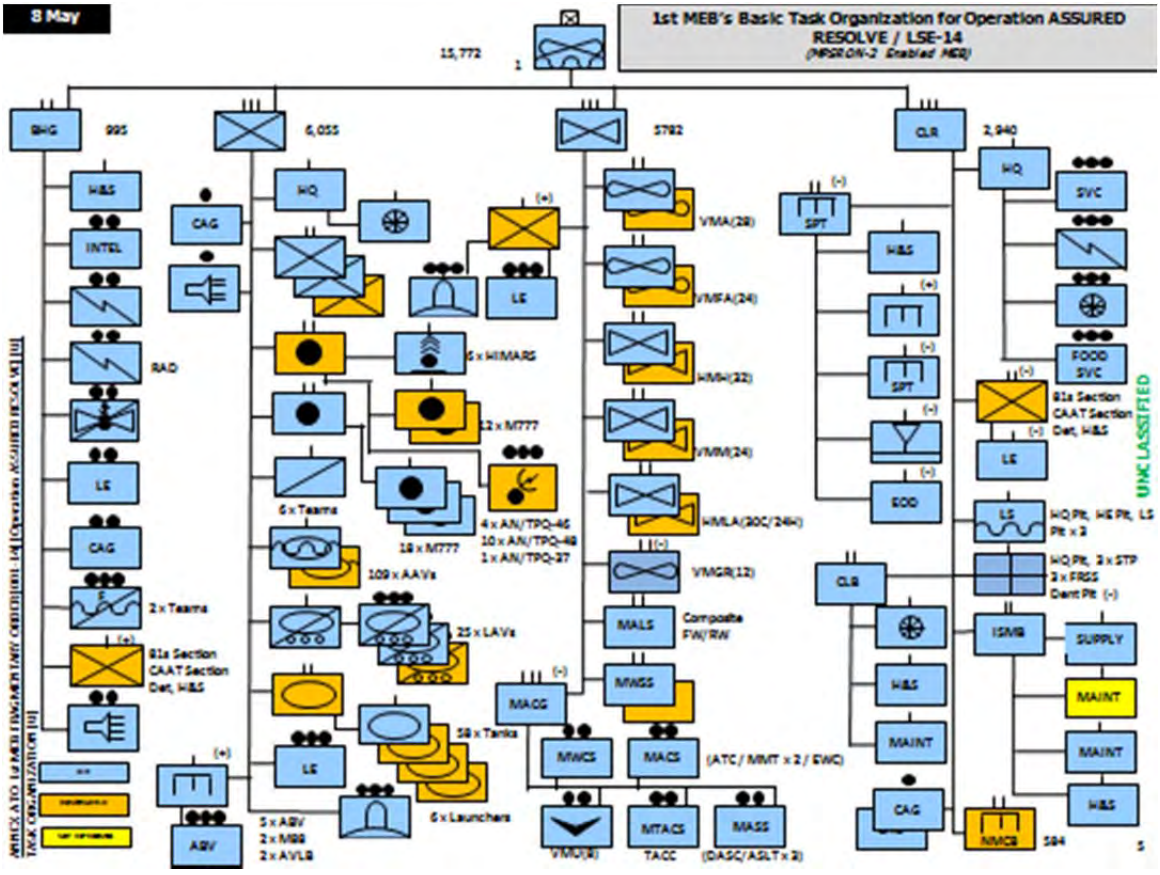

Figure 23. 1st MEB Task Organization for LSE-14 (from 1st MEB, 2014)

2. Why Was LVC Needed for LSE-14?

LVC was needed for LSE-14 due to the constrained training areas and ranges aboard MCAGCC, limited resources to represent complete elements of the MAGTF (manpower and equipment), and budget constraints. In order to properly train the MEB commander and staff, the MEB needs the ability to have all of the forces required for the operation and to be able to operate in a large enough area to maneuver these forces. LVC provides the solution to these problems and was thus the enabler for LSE-14. Whether forces are live in the field or represented in a training system, LVC provides the ability for all units and events to be broadcast to the MEB's COP regardless of the originating source. I MEF's goal was to ensure that 1st MEB received the best training possible—that equated to maximizing the number of Marines trained and improving the training for Marines. Each type of training (live, virtual, or constructive) has its pros and cons—when properly integrated together (i.e. LVC), the gaps (or cons) in one type of training can often be mitigated by one or both of the others.

3. LVC Concept in Support of LSE-14

The best way to show the effect of LVC in support of LSE-14 is to look at the execution of the MEB's operations plan. The final exercise (FINEX) took place from 8–14 August. Actions on 8 August were constructive—this means that all units were represented via the training systems while the live forces physically finished moving into their starting positions prior to 9 August. Live training initiated on 9 August and the MEB's planned scheme of maneuver for that training is shown in Figure 24. As the live forces attacked to destroy MEB objectives A and B, there were subordinate (e.g. 2d Battalion, 4th Marines; 1st Tank Battalion) and adjacent units (e.g. 5th CMBG) that could not be live and were thus represented constructively. RLT-7 accomplished the mission of destroying MEB objectives A and B by the end of 10 August (a day ahead of schedule) and the live forces quite literally ran out of available maneuver space (i.e., the northern limits of MCAGCC). In order to continue the mission to interdict MEB objectives C and D (see Figure 25), the continuation of the exercise had to be accomplished constructively as there are no geographic limitations within MTWS. The use of constructive simulation for large

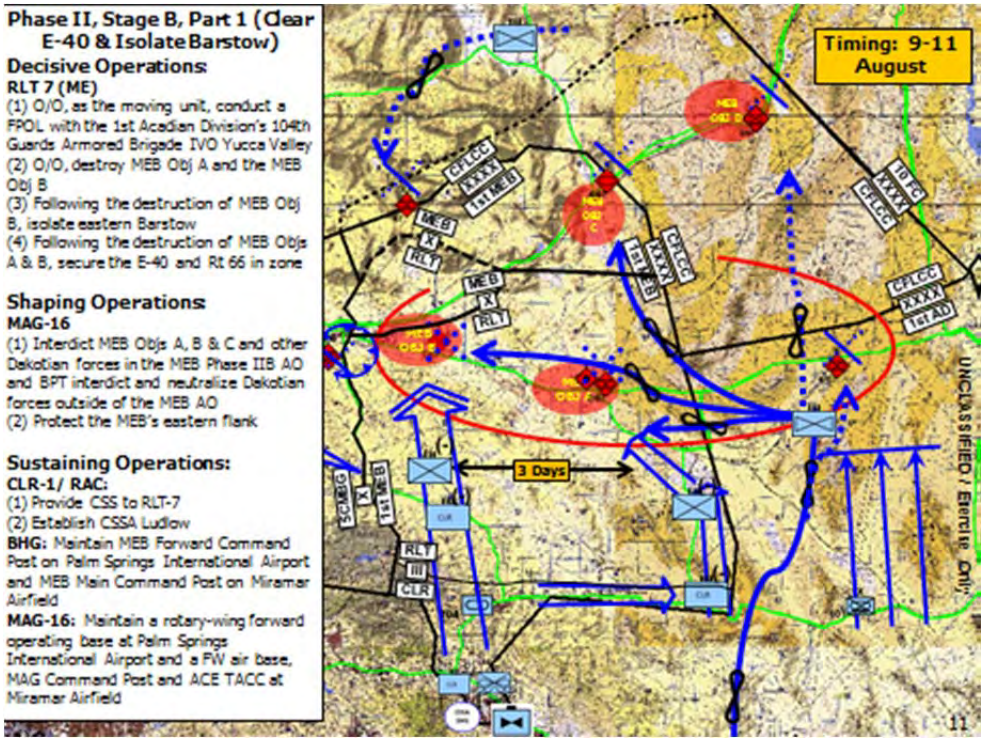

Figure 24. 1st MEB plan during live phase of LSE-14 (from 1st MEB, 2014)

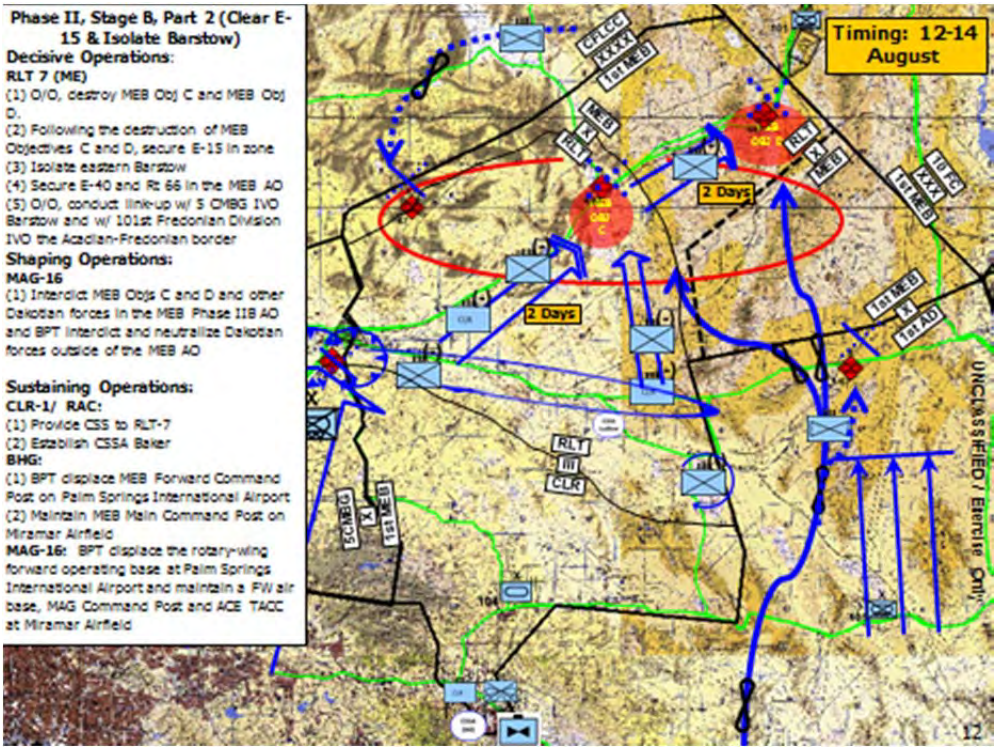

Figure 25. 1st MEB plan during constructive phase of LSE-14 (from 1st MEB, 2014)

MAGTF exercises is nothing new for the Marine Corps, however, what is new is the desire to replace some of the live or constructive events with virtual simulation.

4. LSE-14 LVC Results

One of the primary goals of the PoC in January 2014 was to validate that virtual systems could be integrated and feed "tracks" into the MEB's COP. That same primary goal was achieved for LSE-14. The connectivity as shown in Figure 26 was achieved during the "warm start" period of training for the MEB staff from 4–7 August. Though the final execution phase of LSE-14 was held from 8–14 August, a staff progression period, called a warm start, was the primary window utilized for assessing the connectivity and capability.

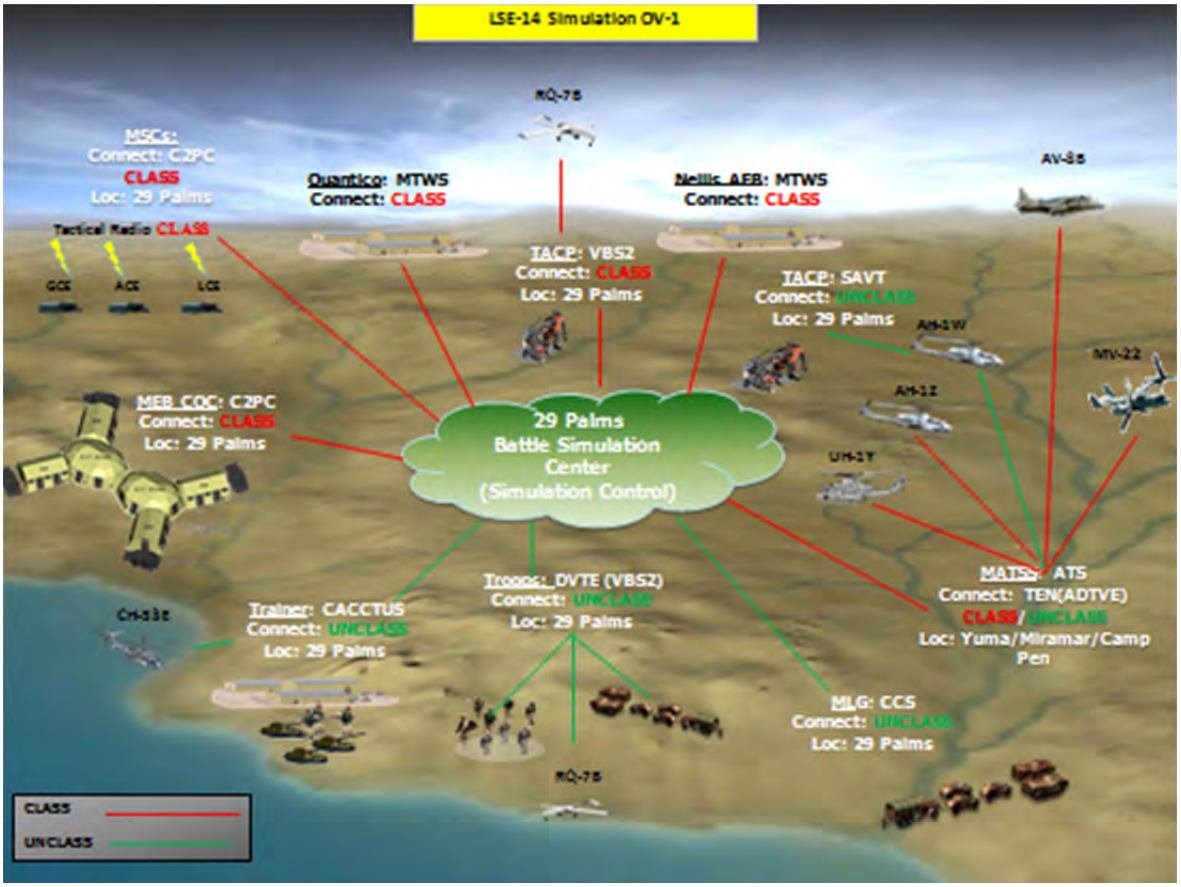

Figure 26. LSE-14 final OV-1 for LVC integration. (from MCAGCC, 2014)

Though there were some technical difficulties in the form of voice communication problems via radio, and virtual trainers "crashing" due to high entity counts or improper configurations for gateway traffic, success was achieved per objective goals—Marines were put into the training systems, placed into their roles (e.g. Joint Tactical Air Controller (JTAC), pilot, convoy commander, vehicle driver, etc.) with simulated equipment, and they conducted assigned missions while coordinating with Marines in other locations. These training missions were conducted while simultaneously allowing the MEB, MSC COCs (i.e. RLT-7, MAG-16, CLR-1), and Exercise Control to maintain situational awareness of their activities and status. This was achieved through using systems on the unclassified side (SAVT, DVTE Virtual Battle Space 2 (VBS2), CACCTUS, Combat Convoy Simulator (CCS), and AH-1W Aircrew Procedures Trainer) and on the classified side (MTWS, ADVTE, DVTE (VBS2)).

The reason that the LSE-14 effort stands out against any other past or recent LVC efforts within the Marine Corps is because the full MAGTF was involved and trained from the individual level to the MEB staff. Often when training systems are used, certain elements/roles are played by contractors, are automated, or are completely excluded in order to simplify the training, reduce costs, or because it was not planned for. While contractors did support many elements of LSE-14 (primarily exercise control and constructive simulation), none of the 1st MEB units were excluded from the exercise–all MAGTF elements and subordinate units had to interact in order to achieve even individual training objectives. This example is best made with the case of JTACs.

When JTACs normally train via systems like DVTE and SAVT, a contractor or another Marine is playing the role of pilot while sitting at another terminal usually just feet away and there is no one playing the role of fire support coordinator or air space coordinator. While this set up may still provide a basic level of training for the JTAC, it is not realistic with regards to how things work during actual operations. The JTACs training via DVTE or SAVT during LSE-14 not only had real pilots on the other end who were flying missions in their own ATS hundreds of miles away but that JTAC had to put in a proper request for support to the direct air support center (DASC) and then wait for the DASC to properly hand the pilot off to the JTAC for execution of the mission. While

this obviously adds in additional opportunities for communication and coordination problems that can slow the training down and make it frustrating, it is these same problems that make the training that much more realistic and effective for the participants (including the MEB commander and staff).

The other piece lacking in the past is that previous events were done in a bubble with very limited visibility by senior leadership and there was usually no continued momentum. With visits from the ACMC and other influential 2- and 3-star GOs, LSE-14 allowed the LVC-TE concept and capability to gain visibility across a broad range of senior leadership. While this is encouraging, LVC-TE will still require a demand signal (or at least continued interest) from their level for continued momentum.

D. FUTURE CAPABILITIES

While serving as the PJM for CACCTUS, I certainly had objectives to take advantage of new technology but it was not until I became involved with LVC-TE that I learned about the many organizations and projects within the science and technology (S&T) community. As shown previously in Figure 4, the Office of Naval Research (ONR) is the technology developer for the Marine Corps. Within ONR, Code 30 (Expeditionary Maneuver Warfare & Combating Terrorism) is the division that is supporting training systems. With respect to training systems, ONR (Code 30), TECD, and PM TRASYS conduct a monthly coordination meeting called the Three Circle Meeting. On a larger scale, the Marine Corps has begun holding a regular S&T focused OAG that is titled the Operating Force Science, Technology and Experimentation (OST&E) OAG. As I became more aware of S&T initiatives, I also became familiar with projects within the Army Research Lab (the Army's equivalent to ONR). For the Army's training systems, the Simulation and Training Technology Center (STTC) provides much of that support. While there are many projects and technologies being developed by these organizations, there are a few projects that offer substantial capabilities to support LVC-TE in the future.

1. Office of Naval Research (Code 30)

a. Augmented Immersive Team Training (AITT)

AITT is a technology nearing the point of maturity to be transitioned from ONR to PM TRASYS for the purpose of support two system-of-systems projects, Force-on-Force (FoF) and Squad Immersive Training Environment (SITE). FoF focuses more on providing instrumented training systems that support live training while SITE is focusing on providing an LVC capability focused at the squad level. AITT provides a capability to allow the users to utilize augmented reality binoculars the same as they would use a set of Vector21B binoculars in order to see and engage targets on the battlefield for close air support or call for fire. In normal live training, the JTAC and forward observer need real targets, real supporting platforms (i.e., aircraft, artillery, mortars), and real ammunition in order to fully execute the T&R standards. Through the augmented reality binoculars and through interoperability with FoF and SITE, any or all of those real supporting elements can be provided instead through augmented reality (ONR, 2014). This training capability not only can potential provide the same fidelity of training as fully live training but at a significantly reduced cost and, if not using real ammunition at all, not restricted to designated training ranges and areas.

b. Decision Making and Learning

With distributed operations at squad and platoon levels starting to become more normal, and with the complexity of the knowledge-base (particular for local culture) needed for these operations, the ability to improve how small unit leaders learn and make decisions is becoming a higher priority. The ability to measure how well an individual learns and their decisions making skills is also a gap that needs to be tackled. Numerous projects like Accelerating Development of Small Unit Decision Making and Perceptual Training Systems are under research and development their results will support improved training methodologies and materiel solutions to support LVC-TE (ONR, 2013).

2. Army Research Lab (STTC)

a. Augmented REality Sandtable (ARES)

ARES may very well prove to be the invasive and necessary technological capability for future military training and operations. The simple concept is to take commercial off-the-shelf (COTS) equipment (projector, flat screen monitor, laptop, and Microsoft Kinect; all roughly $1500) and display terrain, units, coordination measures, weather effects, etc., onto contoured sand in sandtable. In the current ARES proof-of-concept, "the Kinect senses user gestures, changes to the sand "terrain," and potentially, verbal commands as forms of user interaction. ARES projects moving military units, terrain features, and other data onto the sand" (ARL, 2014) (Hedelt, 2014). Figure 27 provides an overview of this basic concept.

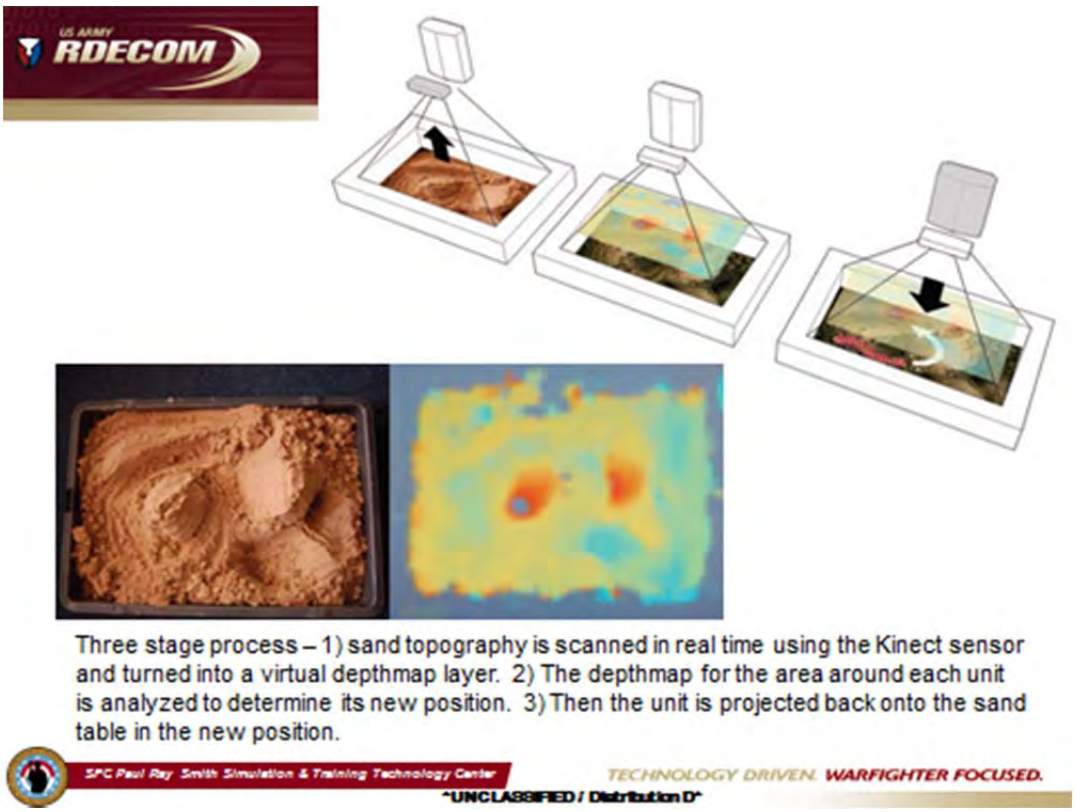

Figure 27. ARES basic concept (from ARL, 2014)

While ARES sounds very simple, and perhaps mundane, the possibilities are anything but that. This concept is one of those where one really needs to see it first hand in order to grasp the potential functionality. Targeted functionalities include (ARL, 2014):

- Improved battlespace visualization.
- Decreased time to author 3D terrains and scenarios.
- Increased student engagement / retention levels.
- Joint/Coalition Wargaming and Mission Planning through networked ARES tables.

The sandtable offers a blank canvas that can be contoured to meet the terrain variations of a map, satellite image, Google earth view, or any other picture that the user needs to see in order to support planning and discussions. Once the user starts to layer in displays of units and personnel, or key infrastructure, or communication analyses results, or any other planning factor that is needed, and the visual capabilities to support collaborative planning should be predictable. Add in the live feeds of forces training via any means of L-V-C and the opportunity for commanders to discuss new options or for entry-level students to fully grasp what an instructor was talking about will be indispensable. Like LVC-TE, the ARES concept and capability will only be limited to the imaginations of its users.

b. Distributed Soldier Representation (DSR)

One of the foundational M&S issues that DSR is trying to address is that "the Soldier, as a complex human, is not sufficiently represented in models and simulations." When individuals train by controlling virtual Soldiers and Marines, those avatars often come across as super humans that need little sleep, food, or water and can run long distances with heavy weight. While simulation developers are adding more realism in order to reduce the opportunity for super humans to exist, there remains a long-term objective to make this type of training experience as realistic as possible for the user. DSR's focuses are:

- Investigate those factors that affect Soldier effectiveness

- Identify where there are gaps in modeling those factors in current Soldier representations
- Offer a service oriented, distributed M&S environment able to assist in filling those gaps

"The DSR long range plan is to provide a capability to represent those human aspects that affect Soldier performance with greater fidelity and an increased realism in the representation of the Soldier within simulations." To achieve any of these objectives, the DSR team is looking at myriad factors that affect an individual's performance on the battlefield: cognition, morale, resilience, human physiology, human psychology, unit cohesion, stress, unit as a complex adaptive system, leadership, decision science, and effects of the Soldier as a family member. Efforts through DSR should not only produce more realistic virtual training for users but could support the development of personal avatars for each user (Diego, 2014).

c. Rapid Unified Generation of Urban Databases (RUGUD)

RUGUD is intended to allow users to generate their own high-fidelity urban environments. With terrain databases often being the limiting factor in a simulation system, this capability can be a critical benefit, particularly towards supporting mission rehearsals while deployed. RUGUD will support this gap by enabling "rapid generation of realistic, geospecific Synthetic Environments for tactical operations" (ARA, 2014).

Current RUGUD efforts are focused on (ARA, 2014):

- Flexible-integrate COTS/government off-the-shelf software
- Open-use open standards and formats
- Automated-rapid production of usable datasets
- Accurate-construct geospecific urban terrain databases
- Consistent-produce correlated databases for disparate systems Complete include attribution for visuals, SAF, maps, etc.
- Detailed-realistic urban representations include interiors, subterranean features, urban clutter, furniture, etc.

Most current training systems require an external source and/or weeks to months of time in order to generate new 3D terrain databases. This process does not support the reality of military operations in which unexpected AOs or new intelligence about an AO requires immediate changes for a simulator to be of use to support exercises, missions rehearsals, or wargaming. This is one of the many reasons why constructive simulation is so heavily relied on at the GO level and virtual systems are relegated for small unit and tactical training. RUGUD's capabilities can significantly improve LVC-TE capabilities in order to allow it to better support all spectrums of T&R.

IV. RECOMMENDED SOLUTIONS

Though there is an active demand signal for LVC-TE in the Marine Corps and though there are programmatic efforts (i.e. CDD development) underway, there remains a lack of a bold and far-reaching vision and any strategy or codified process in order to achieve near-term and long-term objectives with proper integration across the Marine Corps. The Marine Corps needs to define its vision, develop its strategy, educate Marines, get active POCs, and then synchronize efforts. The following are my recommendations for accomplishing this.

A. VISION

The LVC-TE ICD, CONOPS, and vision products from TECD provide many elements of the LVC-TE concept in general terms and do demonstrate the complexity and vastness of LVC-TE, however, a bold and far reaching vision of capabilities is still needed for the Marine Corps. Most people still do not understand or grasp that LVC-TE is not just a concept for integrating or allowing interoperability between training systems (this includes instrumentation and targets for live training along with virtual and constructive simulations). LVC-TE will allow **all** systems (C4I and training) to interoperate and will support not just training and education but also mission rehearsals and potentially mission execution as well. The total effort necessary to fully put this capability in place will require inclusion of most (if not all) HQMC organizations. Most of those organizations are currently unaware of LVC-TE as most are uninterested in learning about a program or concept that they do not think matters to them. With a properly formed vision (as with the EF-21 Capstone Concept), those organizations will see the impact on them and be able to start aligning their planning and operations in accordance. Many parts of the LVC-TE vision may sound like science fiction now but the technological gains in the next 20 years will dwarf those of the past two decades—the Marine Corps' vision must be bold so that it is are poised to incorporate those future capabilities that may seem impossible now.

The following is a prioritized list of elements that the LVC-TE vision should address. Most important are the foundational elements and infrastructure that LVC-TE will need to work off of for years to come. Second in importance are those persistent capabilities that will make LVC-TE available throughout the Marine Corps at a more reduced cost and flexible to meet commander's desires. Last, but not unimportant, are those enabling capabilities that will allow LVC-TE to provide a superior training experience that cannot be replicated elsewhere.

1. Standards and Policy

The only thing that seems certain right now is that LVC-TE will provide the standards and policies that Marine Corps systems and organizations must follow in order to enable LVC. Those standards and policy will have to be mandated and adjudicated in a manner that makes them measurable and allows organizations and program offices to be held accountable. These standards and policy cannot be written in a Marine Corps vacuum though; they must be developed with cognizance of standards being adopted and used by the other military services as well as internationally. Failure to do so will prevent the Marine Corps from properly training and rehearsing in the joint and coalition environments that MAGTFs are expected to be ready for.

2. Facilities

The Marine Corps currently utilizes numerous facilities across the Marine Corps in order to support training system use. Some facilities are permanent and others were built to be temporary. Many facilities were built with other original missions in mind and they have been re-purposed. There are some installations with military construction plans to build new facilities specifically for consolidating many of the current training systems. These plans have been developed though without a full LVC-TE vision and certainly without a strategy in order to ensure that these facilities will meet LVC-TE requirements in the future or even just when they are finally completed in coming years. Facility planning must be fully incorporated into any LVC-TE development process in order to ensure that a proper infrastructure is in place to support LVC-TE now and is flexible for the coming decades.

3. Networks

There is not an expectation that a new network will be needed for LVC-TE but rather that multiple networks will be utilized depending on which systems are being used and the purpose of LVC use. LVC-TE may require enhancements to those networks or vice versa. The LVC-TE CONOPS does a good job of identifying the robust network requirements and concerns.

4. Information Assurance

As defined by Joint Pub 3–12, IA is actions that protect and defend information systems by ensuring availability, integrity, authentication, confidentiality, and nonrepudiation. Training systems are not necessarily information systems but they are often treated that way since they have many of the same components. With the necessity for LVC-TE to further connect training systems with C4I (information) systems, IA is a very important issue that must be thoroughly planned for. LVC-TE should strive to reduce IA risks and simplify the approval process for systems, which are currently hardware centric, to become nothing more than software applications. Though this will not eliminate IA requirements; it will improve the process. The Marine Corps needs classified systems in order to support service-level and joint, interagency, intergovernmental and multinational (JIIM) training exercises and mission rehearsals. The Marine Corps also needs unclassified systems in order to provide accessibility to junior Marines and small units. The costly solution will be to make systems in both classified and unclassified versions, whether housed in the same facilities or separately. That will not be an acceptable solution and so the Marine Corps will need the capability for all systems to be interoperable through a cross-domain solution. The training and mission rehearsal spectrum of LVC-TE should be the leading demand signal to generate new policies and materiel solutions for cross-domain interoperability—current methods are inflexible, costly, and time consuming.

5. Distributed

The Marine Corps already has distributed capability for MTWS and is developing capabilities for other systems but the current objective for distributed operations is

limited to select facilities at the largest Marine Corps bases and stations. Marine Corps objectives need to include Marine Corps Reserve facilities down to the individual I&I staff level. Reserve units and I&I staff are spread across more than 140 sites in 42 states and the District of Columbia (MFR, 2014). Units must currently converge on the same locations in order to conduct training. The time and cost savings will be significant if much of this training can be enabled by LVC-TE. LVC-TE will be a significant leap in training capacity for reserve forces but not unless they are part of the total vision.

6. Virtualization

Virtualization in this case is the act of taking current hardware or software that is meant to "stand-alone" and converting it into a format so that it can be used across multiple sets of hardware or housed on the same hardware with numerous other applications. Virtualization is a significant manner in which to reduce costs and, if applied correctly, can also provide a much more flexible training capability for Marines. IA, the Cloud, and virtualization (for both C4I and training systems) are all interconnected towards supporting Marine Corps goals for reduced costs, reduced hardware footprints, and accessibility.

7. Terrain Databases

Terrain databases have been a critical vulnerability for training systems for years now. I saw it first-hand while PJM for CACCTUS and only saw how wide spread the issue was after taking on the LVC-TE role. Few Marine Corps training systems share the same terrain database software generators and fewer share the same database locations—this means that many of the systems are limited in their value as stand-alone systems and it is very difficult to achieve interoperability without months of lead time for developing new databases. The aviation community (via NAWCTSD) is developing the Marine Corps Common Visual Database for aviation simulators and the Marine Corps should look to use that same database as a means for achieving interoperability (i.e., seamless terrain correlation) across all other training systems (TECD, 2014). As mentioned in the S&T portion earlier, there are a number of potential applications being developed that will allow users to immediately import, manipulate, or develop their own terrain

databases. The long-term objective is to achieve both a worldwide terrain database and an immediate database generation capability so that the latest information from intelligence, surveillance, and reconnaissance assets gives Marines the most recent updates on target areas for mission rehearsals.

8. Shipboard

There are some amphibious transport dock (LPD) variant ships that have been designed with dedicated spaces for the ISMT but that is the limit of training system inclusion right now. DVTE suites and some Combat Vehicle Training Systems (CVTS) versions are deployable but ships are not specifically designed to support them. Amphibious ships (and potentially Maritime Prepositioning Force ships) need to be built and retro-fitted to support current and future LVC-TE systems in order to support training and mission rehearsal while afloat. This shipboard capability can be better supported as well with improved virtualization and modular components. Beyond simply giving Marines an improved training and rehearsal capability for themselves while afloat, the proper integration of C4I and training systems on ships will support improved training integration with the Navy, particularly in the cases of MEUs and Amphibious Ready Groups. The Navy has a very extensive yet intricate shipbuilding and retrofitting plan that the Marine Corps can utilize, but not without having LVC-TE requirements identified and prioritized against this plan.

9. Collaborative Planning

The Marine Corps uses two methods for planning–the Marine Corps planning process (MCPP) and rapid response planning process (R2P2). MCPP is a deliberate process that can be extended over a long period of time while R2P2 is a process primarily utilized by MEUs in order to achieve the start of mission execution within six hours of receiving the mission task. Both MCPP and R2P2 rely heavily on collaborative planning between internal staff members and external staff and agencies. The speed at which collaborative planning can take place is often dependent on communications and information flow. Through applications like ARES, LVC-TE will provide an exponential increase to collaborative planning processes by allowing shared visuals from the small

unit level up to Marine Corps operational and strategic planners and leaders. Whether applied to support intelligence preparation of the battlefield, course of action (COA) design, COA wargaming, staff estimates, confirmation briefs, or myriad other steps in planning, LVC-TE will provide significant efficiencies.

10. The Cloud

The concept of all information and applications being available concurrently to all users is substantial. The ability to make LVC-TE accessible to individual Marines globally, while reducing hardware requirements, will require use of the Cloud.

11. After Action Reviews (AAR)

Training systems are already providing significant enhancements to AARs through the Tactical Video Capture System for live training and separate AAR capabilities in virtual and constructive systems. The problem being created is that there is too much information to provide back to Marines and commanders. The Marine Corps needs to fuse AAR capabilities across LVC-TE systems so that they are all compatible and then provide functionality so that commanders and instructors can immediately tag critical events and incidents in order to reduce the information overload at the end of training. Improved AAR capabilities will also support actual operations in order to provide feedback at the end of missions in order to provide immediate information to intelligence and logistics systems, provide three-dimensional (3D) visuals of actions taken in synchronization with voice communications, and myriad other possibilities. Commanders down to the platoon level should be able to provide virtual in-briefs to deploying units prior to reliefs-in-place in order to give them a flyover of the AO and focus on key leaders and prior engagements through the use of virtual video playback of those events. Whether to provide a more comprehensive but user friendly turnover to incoming units, an intelligence update to the next unit going out, a report to an investigating officer, or to update targeting boards, the AAR fusion of LVC-TE systems will be a significant operational enhancement.

12. Safety

Virtual simulation (particularly in respect to aviation simulators) has always had a distinct capability to allow Marines to perform dangerous tasks within the simulators that are too dangerous to do during live training. Key advances like the position location information capability for individual Marines using the Instrumented Tactical Engagement Simulation System II have already allowed some training events (i.e., night land navigation) to become safer (e.g., improved control and situational awareness for instructors). The same improvements for live-fire and maneuver training can be made in which commanders and staff know where every Marine is and can replay actions as necessary for AARs, investigations, etc. It is only a matter of time until the same capabilities can be introduced into operations in order to reduce fratricide and missing personnel and equipment.

13. Marine Corps Training Information Management System (MCTIMS)

MCTIMS is a web-based application that allows the Marine Corps to manage training information and is a repository for T&R standards (defined as task, condition, measurable standard) and formal courses of instruction. Three enhancements need to be made to MCTIMS for LVC-TE.

a. Linkage to T&R Events

The first enhancement is the ability for any user to pick from a list of training systems and be told what T&R events can be conducted or augmented by that system. Linking training systems to supported T&R events is already an on-going process but requires firm supervision and management for holistic success. Users currently cannot find which training systems support which T&R events without individually looking through each individual T&R event via MCTIMS or searching with the right “key words” in a Word or .pdf version of the T&R manual. There needs to be a more direct method for finding which T&R events a training system can support and vice versa.

b. Linkage to Training Systems

The second enhancement is for training systems to be linked to MCTIMS so that when a T&R event is completed in the training system, then a report is sent to MCTIMS that logs the training for that individual or unit. Through proper cross-domain capabilities, this could then feed into a unit's Defense Readiness Reporting System report in order to support more accurate status on unit readiness.

c. Individual Avatars

The third enhancement is the creation of individual avatars for every Marine. When someone virtually trains with an avatar in systems like VBS2, it is a generic individual that they are controlling. Creating an avatar for each individual Marine that is built to look like the Marine and have the same skills as the Marine, will continue to add more realism to virtual training and make it that much more effective. With MCTIMS serving as the central repository for every Marine's completion of training (i.e., formal courses, physical training scores, annual training, etc.) along with their personal attributes (i.e., height, weight, body type, ethnicity, hair color, etc.), each Marine can have an avatar that is them. Individual avatars will also support future war gaming actions. The same as Framework for Assessing Cost and Technology (Ender, et al., 2012) allows for the individual components of a system to be separately evaluated in order to see what the expected performance and cost outcomes would be depending on the physical properties of those individual components, the incorporation of individual avatars (based on known skills and attributes) will allow the Marine Corps to better predict mission outcomes.

14. Reducing Contractor Support

The program funding for PM TRASYS, as shown in Figure 12, is broken down into mission and customer funds. Mission funds typically means those research and development and procurement funds with which program offices actually develop and purchase systems. The customer funds are then primarily those operations and maintenance (O&M) funds that are used to sustain the services necessary to keep systems available for use each year. For Marine Corps training systems, these O&M funds are often paying for contractors to operate, maintain, and sustain the systems. As the split in

Figure 12 shows, a large aspect of training system cost is going towards contractor support. The need for contractors to support daily operations is cost prohibitive and needs to be minimized (if not eliminated). Through a combination of improved user interfaces, training and education in schoolhouses, AI, AAR tools, etc., the Marine Corps needs to continually reduce the contractor footprint needed to support LVC-TE.

15. Joint, Interagency, Intergovernmental and Multinational

The expectation for joint and coalition interoperability is fairly well understood and will be as capable as the Marine Corps is willing to abide by the same system standards and policies; joint mission essential tasks should be a driving element for this issue. Civilian organizations are also using simulations and LVC more and a proper vision and strategy will allow the Marine Corps to not only conduct warfighting functions in LVC-TE joint and coalition units but also link-in for humanitarian assistance/disaster relief training and mission rehearsals with non-governmental organizations, and local, state, and national governments. The decision that the Marine Corps needs to make is whether or not it will be a leader in establishing JIIM capabilities (strategy and policy are at the core) or will just act as a recipient.

16. Persistent Virtual Marine Corps World

The tactical level is often easy to replicate during training–primarily through live training. The strategic level is often fairly easy to replicate as well–primarily through constructive training and wargaming. It is the operational level that is difficult to replicate because most training is short in duration (hours, days, and occasionally weeks) but the operational level of training requires the service to replicate longer periods of time (weeks to months normally), most notably in the lead up to the training. This operational level training gap is particularly applicable to logistics training as those elements are rarely stressed beyond the tactical level during training. Attempts to conduct operational level logistics training sometimes includes making artificial or temporary changes within an actual logistics system in order to go through the actions of requesting parts, supplies, etc., but can have an adverse effect on actual Marine Corps daily operations if not properly coordinated and supervised. With a persistent virtual world, the Marine Corps

can have a separate but mirrored environment in which operational actions can take place weeks or months in advance of training so that the logistics training audience is already being stressed at the start of the training and their actions have made an impact (positive and negative) on the readiness of LVC forces at the start of the training.

17. Plug-in and Wireless Concepts

LVC-TE must not be a difficult capability for commanders to access; it must be accessible to commanders and their units globally. Remembering that LSEs and MAGTF training is only one element of the LVC-TE capability, the Marine Corps needs to ensure accessibility to individuals and small units. Many current facility plans call for co-locating all or most training systems at a base. This may be a good course of action at locations like 29 Palms, Hawaii, and Quantico (smaller installations with most personnel and units centrally located) but will likely not be conducive to the numerous units at locations like Camp Lejeune, Camp Pendleton, and Okinawa (large installation areas with personnel and units spread throughout). Commanders want their Marines to be able to plug-in for training in their barracks and command posts. Decisions will have to be made on which systems this would apply to but this needs to be a primary objective for enhancing T&E at many formal schoolhouses (TBS, 2013). As IA, virtualization, and Cloud concept and capabilities our matured, they need to be done so with wireless connectivity in mind for all Marines to join the LVC-TE network(s).

18. Enabler for training, education, mission rehearsal, and maybe even mission execution

The training application seems fairly straight forward for LVC-TE as that appears to be the primary focus right now. The education application still needs to grow with LVC-TE systems being utilized to support instruction within Education Command (EdCom) courses. The fusing of the training and education application will take place when EdCom students are able to watch and discuss the conduct of training in real-time (or in playback). An entire Expeditionary Warfare School class will be able to sit around a virtual sand table the size of a basketball court and watch the LVC execution of an LSE as the individual Marines and vehicles (regardless of them being live, virtual, or

constructive entities) are projected onto that virtual sand table and the class can hear real-time radio traffic and see information flow in chat windows. The mission rehearsal capability will most notably support EF-21 by allowing entry forces to provide live intelligence information that allows afloat and land-based deploying forces to rehearse in virtual and constructive simulations. The key enabler for mission rehearsals is not just the linkage of all Marines and units that will conduct the mission but the ability for it to be done in the appropriate required terrain and environment (both virtually and live (pending permissibility); constructive is already available worldwide). The bold vision is that LVC-TE will one day provide the "Ender's Game" warfighting capability. At the end of *Ender's Game* (Card, 1985), Ender virtually sees and controls the composited Earth force that is attacking the alien enemy force. With the increasing use of unmanned systems, it is not too far-fetched to suggest that the Marine Corps can conduct future operations from afar with commanders and operators virtually employing unmanned systems as a composited force.

19. Dismounted Virtual Immersion

Virtual immersion for vehicle and aircraft crews is available today because the tasks for those personnel allow them to remain rather stationary inside a replicated vehicle cab, aircraft cabin/cockpit, etc., while surrounding screens and mechanical motions can provide the realism of movement and stimulation of senses. These platforms are also often the most expensive to operate and the most expensive to replace in cases of mishaps, so the return on investment in high fidelity simulation has allowed better capabilities to be produced and sustained. The Marine Corps is an infantry centric organization though and this means that most of its personnel conduct operations while dismounted and walking around on terrain. Providing virtual immersion for this type of training is much more difficult given the desire for the individuals to be able to walk for extensive distances in varying terrain. The only current capability for individual Marines to participate virtually on foot is through DVTE (VBS2). This means that they are pressing keys or moving a joystick in order to move around the battlefield. This limits the realism of the training as well as the number of personnel that can be involved in the training at one time. This still leads many Marines to think of systems like DVTE to be a

game and not real training. The Marine Corps needs to achieve a capability for individual Marines to train on foot virtually with their tactical equipment while actually walking and running through virtually immersive simulation.

20. Augmented Reality

An easy way to grasp a key concept of augmented reality is to think of the Jedi Council meetings in Star Wars movies where real people are able to directly interact with computer generated and projected individuals (holograms). Augmented reality is going to provide the Marine Corps with the capability for live Marines to train alongside virtual Marines in a manner in which they can both see and interact with one another and the environment that they are operating in. Augmented reality will include the ability for Marines to simultaneously engage live and virtual targets. As mentioned earlier, one of the shortfalls of live training on ranges is that it is often predictable. This is because anyone that uses a range more than once will often see the same target(s) in the same location(s) and often there is prescribed manner (orientation to the target(s)) that limits the options. Augmented reality will allow Marines to engage targets that can be seen and look real but can be quickly and easily relocated on ranges as well as modified to present varying levels of threat to the attacking force. Augmented reality will also significantly enhance collaborative planning.

21. Human Behavior Representation and Artificial Intelligence

The Marine Corps extensively used role players as part of Operation Iraqi Freedom and Operation Enduring Freedom pre-deployment training because the human interaction is essential to developing cultural skills but also because current AI capabilities are less than adequate, too expensive, or both. With the focus on global crisis response (CMC, 2014) now, the Marine Corps must make considerable advancements in the cultural realism (human geography) of LVC-TE. This “culture” will be an additional layer on top of the worldwide terrain database requirement and should include the injection of avatars for specific targets (kinetic and non-kinetic) that have foreign language capabilities. Many current training systems provide exceptional decision making training to leaders because they allow for the normal friction inherent in the C2

of operations. The enhanced AI capabilities will greatly improve this decision making training because each individual decision and interaction with virtual avatars will have its own distinct realistic result and consequences.

22. Environment Replication

The science fiction objective has always been the Star Trek holodeck. With the holodeck capability in mind as the final objective, the Marine Corps needs to begin making strides towards replicating operational environments within its virtual simulators with enhanced visual, aural, olfactory, and touch stimulation.

B. STRATEGY

The vision for LVC-TE should be broad and audacious but should not be confused as something that the Marine Corps needs to fully achieve in a short-term. LVC-TE is a long-term capability with some aspects that the Marine Corps has not even thought of yet. As proven during LSE-14, there are many near-term capabilities that the Marine Corps can achieve but not without a cohesive strategy that will allow the necessary resources to be properly identified, prioritized, allocated, and applied in support of LVC-TE.

1. New Start

It still needs to be decided if LVC-TE will actually be a new program or will instead attempt to utilize funds via existing Marine Corps programs. Reluctance exists to make LVC-TE a new program and this reluctance needs to be nullified. LVC-TE needs to have its own separate line for funding and requirements in order to remain agnostic about other programs and properly serve as the primary materiel solution for the full concept.

2. Educate the Marine Corps

Few Marine Corps personnel understand the LVC-TE concept and capability and even fewer are in positions to directly assist in the development and implementation. Further development efforts will be insufficient or negative without educated participants. This education effort needs to be wide-spread initially and then presented in

a persistent manner via EdCom, MAGTFTC, and MSTP courses. The list of initial education venues includes at a minimum:

a. GO Executive Off-Site

b. Sergeants Major Symposium

c. Boards

(1) Command Element Advocacy Board (CEAB)

(2) Ground Board (GCE advocate)

(3) Aviation Board (ACE advocate)

(4) I&L Board (LCE advocate)

(5) Marine Installations Board (Facilities)

d. OAGs

(6) GCE Combined OAG

(7) I&L T&E OAG

(8) Marine Air Control Group OAG

(9) Unmanned Aerial System COAG

(10) Aviation Ground Support OAG

(11) ATS Training Management Team (TMT)

(12) MAGTF T&E OAG

(13) MEB OAG

(14) MEU OAG

(15) OST&E OAG

e. Force Synchronization Conference

f. Operations Summit

g. Commander's Course

h. I&I Conference

i. Senior Gunner Symposium

j. HQMC Action Officer Course

k. TECOM

(16) TECOM Action Officer Course

(17) MSTP

(18) MAGTFTC Commands

- Marine Corps Tactics and Operations Group (MCTOG)
- Marine Aviation Weapons and Tactics Squadron-1 (MAWTS-1)
- Marine Corps Logistics Operations Group (MCLOG)
- Tactical Training Exercise Control Group
- Mountain Warfare Training Center

(19) EdCom Courses

- Marine Corps War College
- School of Advanced Warfighting
- Command and Staff College (CSC)
- Expeditionary Warfare School (EWS)
- Staff non-commissioned officer (SNCO) Advanced Course
- SNCO Career Course

l. Naval Postgraduate School's (NPS) Modeling, Virtual Environments and Simulation (MOVES) program

3. Identify LVC-TE Subject Matter Experts (SME) and Points of Contact (POC)

Having the right personnel involved in developing LVC-TE is a necessity but cannot be achieved until the initial education piece is first achieved. The Marine Corps does not need a revolving door of participants waiting for organizations to get it right or finally realizing how important the effort is. There is a tendency within acquisitions to call any systems expert a SME. A SME must be a uniformed Marine that is not only an expert with a system but in that system's application to support training and operations. This distinction, along with the right SMEs and POCs, is essential to future success. The majority of individuals involved with developing and implementing LVC-TE must be uniformed personnel—this cannot be something that is set-up for civilian management and heavy contractor support. While there are many qualified civilians that run programs throughout CD&I and MCSC, I believe that the LVC-TE capability will be such a daily part of Marine training that its development and sustainment must be overseen by a uniformed Marine.

4. LVC-TE Working Group Charter

When LVC-TE efforts in TECOM renewed in March 2013, there was an initial fervor to create a formal LVC-TE WG with a number of Sub-WGs. Though there was a formal LVC-IPT Charter to work on the ICD (TECOM, 2006) and though LVC-TE WG meetings were held by TECD on 20 March 2013, 22 January 2014, and 3 April 2014, there is still not a formalized core group of LVC-TE WG members or a formally stated purpose and objectives for the WG. This can be rectified by establishing a formal LVC-TE WG Charter similar to the one for the ICD development and similar to the Training M&S WIPT Charter. I believe that the absence of a formal charter has been a contributor to the exclusivity of action officers that should be part of the process at this point. As part of the formal process to inform the Training M&S WIPT and MAGTF T&E OAG, a formal LVC-TE WG Charter needs to be established with a designated CIO (uniformed Marine) as the lead integrator (ideally that is his/her only duty). Initial priorities of the LVC-TE WG are to re-assess prioritization of the ICD gaps, DOTMLPF-P assessment,

and generation of LVC-TE Sub-WGs to begin addressing these areas in more detail (Sub-WG leaders should also be uniformed Marines).

5. LVC-TE Roadmap

The 2010 Training Modeling and Simulation (M&S) Master Plan provided a detailed plan to achieve a number of capabilities within LVC-TE but it has not been a document that the Marine Corps measured itself against in recent years. I believe that it was not streamlined enough to be user friendly (easily managed) and once some milestones were not met, the Training M&S establishment abandoned it as a guidebook. The 2014 Training M&S Master Plan (currently in final draft) will be the replacement document and provides greater flexibility. It also provides a general integration roadmap (Figure 28) and this will be a guiding tool but the Marine Corps still needs a much more

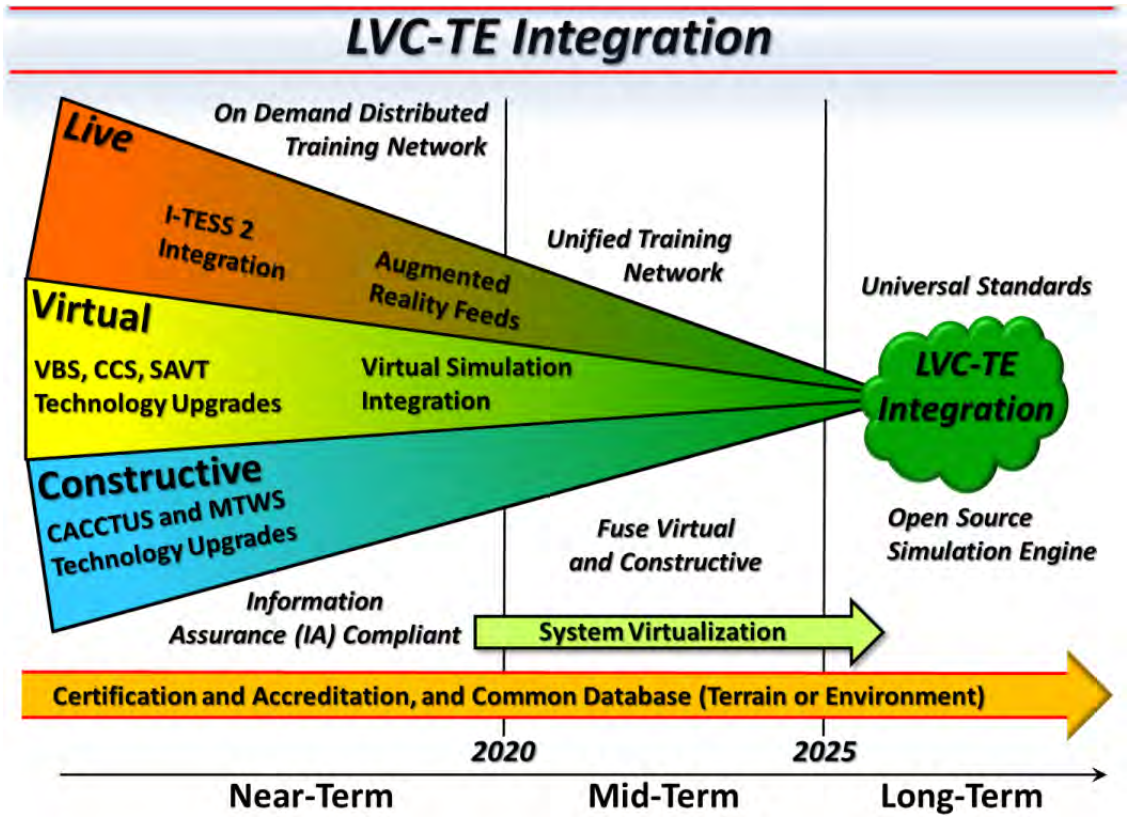

Figure 28. LVC-TE Integration Roadmap from new Master Plan (from TECD, 2014)

detailed LVC-TE roadmap to plan with and deviate from. Though all DOTMLPF-P actions should be part of this LVC-TE roadmap, the Marine Corps specifically needs a training systems/LVC-TE roadmap by which to plan better materiel acquisition strategies. The Marine Corps currently has no idea when any of its training systems are supposed to be disposed of, replaced by new systems, or merged with other systems. The Indoor Simulated Marksmanship Trainer (ISMT) is a great example of this.

When I was a Naval Reserve Officer Training Command (Marine Corps option) midshipmen in 1994, I was introduced to the ISMT for the first time. It was a large screen with a projector, realistic but simulated weapons, and software to provide an interactive environment for marksmanship training. 20 years later, the ISMT has improved with more software capabilities, a larger set of weapons to train with, and some weapons are now connected by Bluetooth technology (as opposed to tethered lines) but the ISMT, for all practical purposes, is still the same concept and capability that it was two decades ago with no plan to replace it, dispose of it, or revolutionary change it for future years. Why is this? How is it that hundreds of millions of dollars has been invested to provide a stagnant system that is not portable, requires significant training to operate, is not interoperable with other training systems, and requires "training" weapons to be utilized instead of Marines' actual weapons in order to reduce costs and increase training effectiveness? The reason is because that the ISMT, along with all other training systems, has no roadmap to follow and plan from.

Weapons, aircraft, and other platforms have life-cycle plans by which the program offices can plan service life extensions, replacement, and disposal. Without an existing roadmap for Marine Corps training systems, PM TRASYS cannot do this planning. A detailed training systems roadmap is also essential for aligning training systems with critical C4I systems (e.g. Advanced Field Artillery Tactical Data System (AFATDS), Strikelink, VideoScout, etc.).

Figure 29 is from the Marine Corps Aviation Plan and is often referred to as the AVPLAN (MROC, 2013). Though obviously lacking many details, this picture has made it very clear to Marine Corps planners what the objective is for the modernization of

Marine Corps aviation platforms. This same type of picture is needed for Marine Corps training systems and LVC-TE; Figure 27 currently falls short of doing so.

Figure 29. Marine Aviation Modernization Concept (AVPLAN) (from MROC, 2013)

Figures 30 and 31 are examples pulled from IDs within the Capabilities Development Directorate at CD&I. There are numerous other roadmaps like these that can be found for many other communities and families of systems. As with the AVPLAN, there are more detailed plans that accompany these pictures but these visuals provide a clear message as to which systems support a particular community/function, when these systems are initially and fully operational, and how long these systems are needed to be in service. Similar roadmaps are needed that account for all current and future training systems and, then, a hybrid plan is needed for LVC-TE that infuses the ideas in Figure 28 with the AVPLAN concept. As a PJM for training systems and LVC-

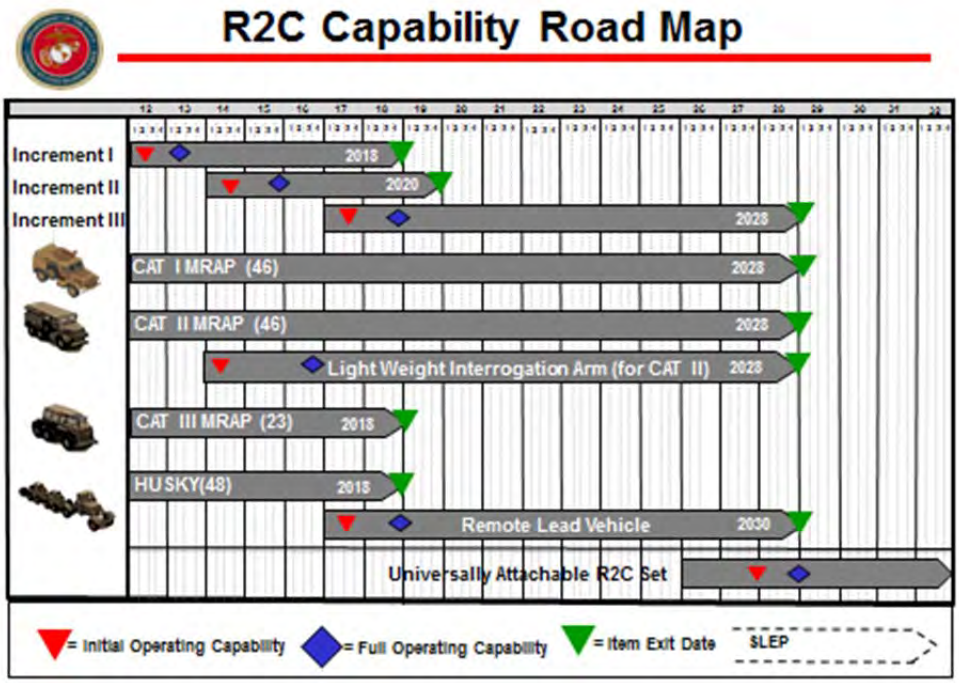

Figure 30. Route Reconnaissance and Clearance (R2C) Capability Road Map (from Rock, 2013)

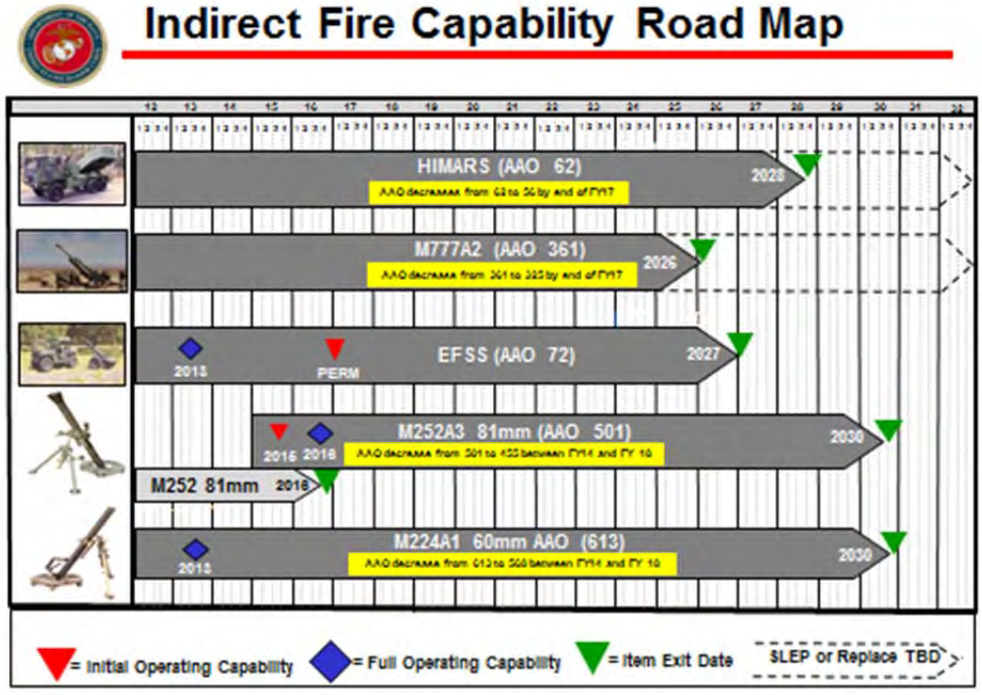

Figure 31. Indirect Fire Capability Road Map (from Penella, 2014)

TE, I look at Figure 28 and am still unsure of what the final vision for LVC-TE looks like and what the plan is to get there.

6. Improve Requirements Process for Training Systems

Marine Corps training systems are rightfully criticized for having stove-piped capabilities. They have stove-piped capabilities because they have stove-piped requirements and they have stove-piped requirements because the Marine Corps has failed to follow a standard requirements process (for new as well as continuing improvements).

a. Configuration Control

Except for the case of MTWS, PM TRASYS has failed to hold regular CCBs on an annual basis, if even a bi-annual basis. This has been for a number of reasons but the normal excuses have been either that the systems already have requirements for enhancements (though those requirements may be old) or that funds are not available for enhancements so the CCB should be postponed until funds are available. In order to achieve the same synergy that the Training M&S WIPT and MAGTF T&E OAG can provide, PM TRASYS must hold annual CCBs for all training systems and do so in a manner similar to the T&R manual reviews and TMTs via a published Marine administrative instruction identifying the training system(s), dates, and location of the CCB. If it is possible and makes sense to combine CCBs or hold them in conjunction with the Training M&S WIPT, then that should be done as well.

b. Training M&S WIPT

Appendix D of the 2010 Training and Education Modeling and Simulation Master Plan is the Training M&S WIPT Charter. This Charter was signed by the CGs of TECOM, MCWL, and MCSC; the Deputy Chief at ONR; and the Senior Analyst at MCCDC. The Charter clearly outlines the purpose of the Training M&S WIPT as (MTSD, 2010):

> "a. The Training M&S WIPT will provide an overarching forum to identify training M&S needs across the Marine Corps and it will serve as a

> mechanism to address any identified gaps. The purpose of the Training M&S WIPT is to function as a training M&S information clearing house.
>
> "b. The goal of the Training M&S WIPT is to foster information exchange, identify needs/challenges, develop course of action to address identified needs, and to facilitate development of requirements documentation."

In order to emphasize the importance of the Training M&S WIPT, CG TECOM published TECOM Policy Letter 1–10 in 2010 as well. With a firm emphasis on the importance and far-reaching capability that LVC-TE will be able to provide the Marine Corps for training and mission rehearsal, the mission statement was very clear (TECOM, 2010):

> "TECOM will establish a systematic and disciplined process to identify, prioritize, coordinate, and address training and education M&S issues in order to facilitate development and integration of live, virtual, and constructive training capabilities to meet Marine Corps training and education needs."

Despite the high level leadership involved in signing the Training M&S WIPT Charter and clear direction from CG TECOM on its importance and the need for it to be part of disciplined process (quarterly meetings), the Training M&S WIPT has only been held five times since; twice in 2010, twice in 2011, and the last was in March 2013.

c. MAGTF T&E OAG

The MAGTF T&E OAG was established in 2003 (MCCDC, 2003). As with the Training M&S WIPT, the purpose of the MAGTF T&E OAG is well stated (MCCDC, 2003):

> "The MAGTF Training and Education Operational Advisory Group (T&E OAG) is chartered as a forum for establishing Marine Corps training and education priorities. The MAGTF T&E OAG provides interaction between Training and Education Command (TECOM), the operating forces, and the Advocates, in order to provide timely coordinated solutions for validated training and education requirements that have a critical impact for the Marine Corps."

The MAGTF T&E OAG has been held three times–once in 2003, May 2013, and March 2014. Where other OAGs that I have attended have resulted in top ten lists of

priorities, neither of the last two MAGTF T&E OAGs has produced a list of priorities. The MAGTF OAGs have instead been used more as an opportunity for TECOM to pass on information to the operating forces and advocates and receive concerns back in return. This may be because many T&E priorities can be identified and socialized at other OAGs (i.e. GCE COAG, I&L T&E OAG, Aviation OAGs) and TECOM is not looking to duplicate efforts but there are no other OAGs available to directly address LVC-TE, thus, LVC-TE issues routinely lack institutional socialization and prioritization.

d. Lack of Synchronization

The failure to conduct the MAGTF T&E OAG and Training M&S WIPT in a synchronized and recurring manner has allowed the training systems requirement process to become stale and has atrophied institutional knowledge of training systems and LVC. If conducted properly, the Training M&S WIPT will allow the Marine Corps to directly address training system requirements for interoperability and those decisions can be presented to the MAGTF T&E OAG for concurrence or reprioritization in accordance with the full training and education spectrum of LVC-TE that TECOM is responsible for. The outputs from the MAGTF T&E OAG should then be presented at the GO CEAB for proper alignment with MAGTF priorities. If this process was conducted semi-annually (as is done in other communities), it would greatly assist in establishing institutional understanding of training systems and LVC-TE. It would just as importantly allow for validation of current and future requirements to support interoperability across training systems and the MAGTF. The Marine Corps will continue to kick the LVC-TE can down the road until it is willing

7. Science and Technology

Many capabilities within the LVC-TE vision are years, possibly decades away, from reality. S&T is a critical element for LVC-TE to reach FOC and efforts across the numerous S&T agencies (Defense Advanced Research Project Agency, ONR, ARL, etc.) must be tracked, prioritized, and aligned wherever possible. LVC-TE concepts should be akin to the National Aeronautics and Space Administration with regards to new capabilities—S&T efforts within LVC-TE may not always lead to a direct LVC-TE

capability but may often result in a capability to support other training programs or warfighting functions.

8. Industry and Academia Involvement

The Marine Corps has allowed a delay in the LVC-TE materiel solution development to stagnate its knowledge and intellectual development on the subject. The Marine Corps' focus on identifying system integration requirements has inadvertently resulted in a significant delay towards all other aspects across the DOTLMPF-P spectrum. This does not mean that the Marine Corps does not have some well qualified and knowledgeable experts on LVC-TE but, as an institution, the Marine Corps has not attempted to increase the number of experts and informed personnel.

The Marine Corps is about a decade behind the Army, Navy, and Air Force with regards to actually developing enterprise LVC capabilities. With LSE-14, the good news is that the Marine Corps is potentially leading the way with regards to more complete virtual and live interoperability. There are enough common interests as well to allow the Marine Corps to do some quick catching up through lessons learned and continued interactions with the other services. The true ability to take a giant leap forward thought will take place once the Marine Corps fully gets industry and academia involved. It is not that industry and academia are not doing anything that can support the Marine Corps now, it is that much more can be done, without expense to the Marine Corps, with a full vision and clear capabilities established for those institutions to set their sights on. Though academia is focused on knowledge growth and industry is focused on profit growth, they both can equally gain from tackling Marine Corps LVC-TE capability requirements but will be hesitant to invest resources if they do not see a long-term commitment and institutional plan from the Marine Corps that provides a potential return on their investments. After confirming ICD gap priorities again, the Marine Corps needs immediately to conduct industry days and ask industry and academia for white papers and thesis efforts in order to expand knowledge at a faster pace and reduced cost than the Marine Corps can do on its own.

9. Experimentation

The LVC-TE CONOPS focuses on LVC-TE support for MEBs, MEUS, and SPMAGTFs—that is where Marine Corps experimentation should focus as well. PM TRASYS has begun an initial relationship with the Marine Corps Warfighting Lab (MCWL) but it has been nothing more than an exchange of information on each organization's current projects and objectives. MCWL should be an internal part of LVC-TE experimentation efforts—particularly with regard to SPMAGTFs and MEUs. The Force Synchronization Conference should be used as an opportunity to target SPMAGTFs and MEUs for experimentation efforts. MEB training and mission rehearsal will become the model for LVC-TE and MEBs will likely be the MAGTF that benefits the most. The annual LSE should have an experimentation requirement. MAGTFTC, MSTP, and the participating MEB should be tasked to experiment with LVC-TE in order to improve training for the primary and secondary training audiences while reducing cost. Joint experimentation should be targeted with select Army (semi-annual Network Integration Evaluation), Navy (annual Bold Alligator with II MEF), and Air Force (Virtual Flag) exercises as well.

C. EXPEDITIONARY FORCE 21

As the Marine Corps has begun to pull itself away from combat operations in Afghanistan, it has refocused on being the crisis response force for the United States. The vision for designing and developing the force to meet these responsibilities is EF-21. EF-21 has been presented as a Capstone Concept that is central to further Marine Corps planning. As stated by General Amos, Commandant of the Marine Corps, "…it is more than a vision – it is also an actionable plan and a disciplined process to shape and guide our capability and capacity decisions while respecting our country's very real need to regain budgetary discipline. Through Expeditionary Force 21 we will chart a course over the next 10 years to field a Marine Corps that will be: *the right force in the right place at the right time*." (HQMC, 2014)

LVC-TE concepts and capabilities support a number of elements and objectives within EF-21. A significant portion of the vision and strategy for LVC-TE should focus

on aligning with EF-21 in order to better meet future Marine Corps requirements. The following is a summary of those key elements and objectives within EF-21 and how LVC-TE can support.

1. C2, Fires, Intelligence, and Logistics Integration

Most Marine Corps training systems have integrated tactical radios, BFT, and C2PC or can directly stimulate those and other C4I systems. Additionally, many training systems have a focus on combined arms training with integrated C4I systems such as AFATDS, Target Location Designation Handoff System, and VideoScout. The Marine Corps has proven the technical ability and training benefits of linking ATS with MAGTF training systems and can bring in live or virtual unmanned aerial systems as well. LVC-TE can grow into a holistic fusion of systems that further links naval surface fires and joint ATS. A gap in Marine Corps logistics training remains at the operational level because most training events and exercises are often too short in duration to stress operational logistics. LVC-TE can provide a robust virtual world in which logisticians can be involved before and after event execution and thus encounter operational issues that often fail to be replicated today. By continuing to integrate and link training systems and C4I systems within the EF-21 and LVC-TE concepts, the MAGTF can have a persistent and dynamic environment in which to achieve T&R across these warfighting functions.

2. Joint, Coalition, Maritime, Naval, and Special Operations Forces Integration

LVC is a global objective and the other services (including Special Operations Command and the Coast Guard) and many international partners and allies are generally on parallel paths developing their own capabilities. LVC-TE efforts can be integrated with theirs to provide a readily available T&R capability that allows MAGTFs to better develop habitual relationships, standard operating procedures, and conduct mission rehearsals without the need to use exhaustive resources (i.e., aircraft, armor, ships) or be co-located until ready for a live assessment or actual crisis response.

3. Security Cooperation

Whether developed by them or provided by the United States, many partners and allies are using LVC capabilities or want to develop them. The Marine Corps can leverage this to better achieve theater engagement and security cooperation at a reduced cost. LVC-TE can be a critical link in this endeavor as a means to better integrate tactically and operationally while reducing deployment of personnel to those countries.

4. Situational Awareness, Decision Making, Experimentation, and Wargaming

The Marine Corps is continually seeking to make its leaders and organizations more dynamic and efficient in solving problems. Much of this training comes from giving Marines experiences in which they can develop better situational awareness, learn from their successes and mistakes, and feel free to try new things. LVC-TE can provide those experiences from the individual level to senior executives and do so in a manner that is repeatable, cost effective, tutorial in nature, and accessible to every Marine.

5. Return on Investment

Though the Marine Corps is continually assessing training effectiveness, studies have shown that training systems can provide training at substantially lower costs than live training (GAO, 2011) (PM TRASYS, 2014a). Previously mentioned efficiencies of LVC-TE are that it can train distributed forces, replicate the use of resource exhaustive equipment, quickly repeat training events without expending additional resources, and reduce maintenance requirements—all of this equates to cost savings. Measurable time savings additionally come from the quick reset from one training event to the next along with comprehensive AARs (including 3D playback with voice overlay) that accelerate the learning cycle.

D. IMMEDIATE ACTIONS TO BE TAKEN

The LVC-TE problem is intricate but near-term and long-term solutions are available that do not require extensive resources. As with many problems, solutions start with leadership. The Marine Corps needs a clear signal from senior leadership in the form of a

well-articulated vision and planning guidance. That vision should align with how LVC-TE will support EF-21 goals and that guidance should focus on immediately addressing T&E and integration gaps.

1. Training, Leadership and Education

The Marine Corps does not need to start from scratch to formally introduce LVC-TE into its T&E continuum (Figure 32). Valid curriculum examples exist within the Army's FA57 (Simulation Operations) school; NPS's MOVES program; MSTP instruction; and Infantry Weapons Officer Course (IWOC) learning objectives.

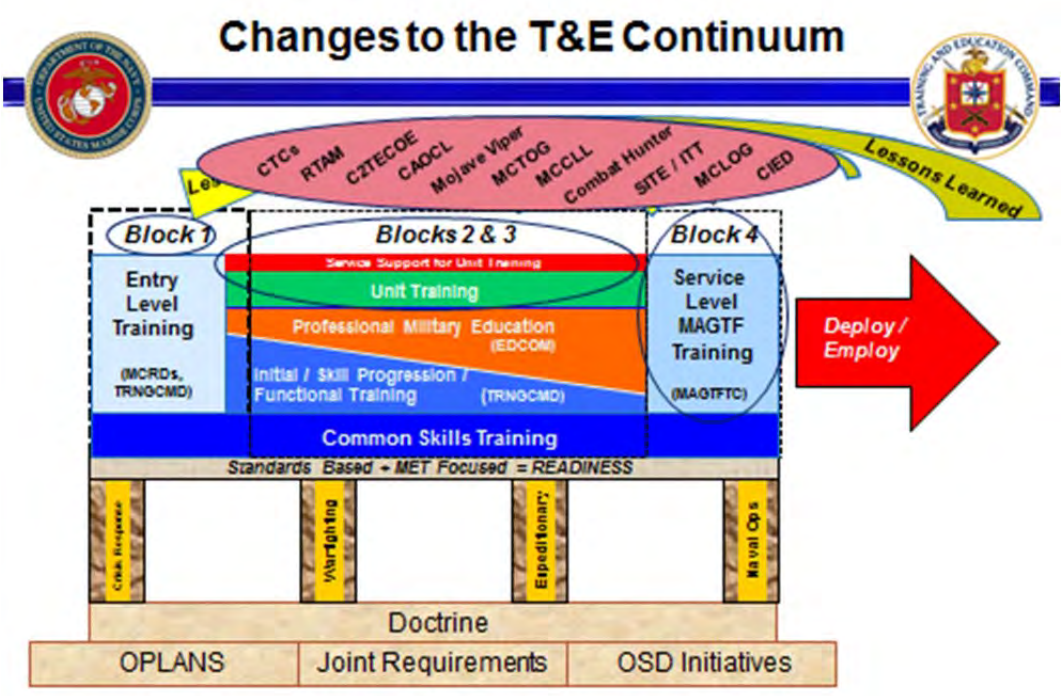

Figure 32. TECOM T&E Continuum concept (from TECOM, 2013a)

a. LVC-TE in Support of Training Plans

One of the current gaps that exist is the ability for Marines to know how to apply training systems and LVC-TE capabilities against unit training plans. In effort to start to correct this deficiency, the Gunners community has identified learning objectives as part

of the IWOC. Though developed specifically for the Gunners' needs, this terminal learning objective (TLO) and enabling learning objectives (ELO) can be applied to formal train-the-trainer courses.

(1) TLO: 0306-TRNG-2002 Given a training scenario, advise on the incorporation of simulations to enhance training.

(2) ELO: 0306-TRNG-2002a Given a scenario, training plan, METLs, references, simulations, and regulations, conduct cross analysis to match simulations with training requirements.

(3) ELO: 0306-TRNG-2002b Given a scenario, training plan, METLs, references, SDZs, simulations, and regulations, incorporate simulations into training plan to meet the commander's intent.

(4) ELO: 0306-TRNG-2002c Given a completed training event using simulations, conduct an After Action Review (AAR) to correct the identified training deficiencies.

(5) ELO: 0306-TRNG-2002d Given a completed training event using simulations and an after action review (AAR), communicate results of AAR to higher to report simulation capability/limitations.

In response to a request from the IWOC, I provided a two-day period of instruction to the newest class of Gunners in July 2014. Figures 33 through 36 below are extracted slides that I provided in order to meet the TLO and ELOs. Though further analysis and application development is needed by more Marines, I believe that this provides an actionable set of tactics, techniques, and procedures (TTP) for Marines to apply training systems and LVC-TE against their unit training plans.

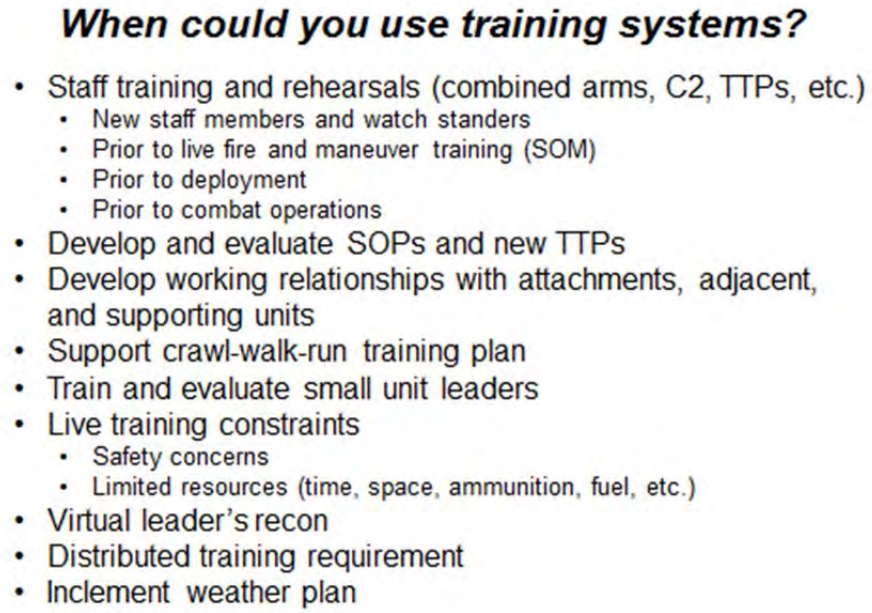

Figure 33. Examples of when to use training systems

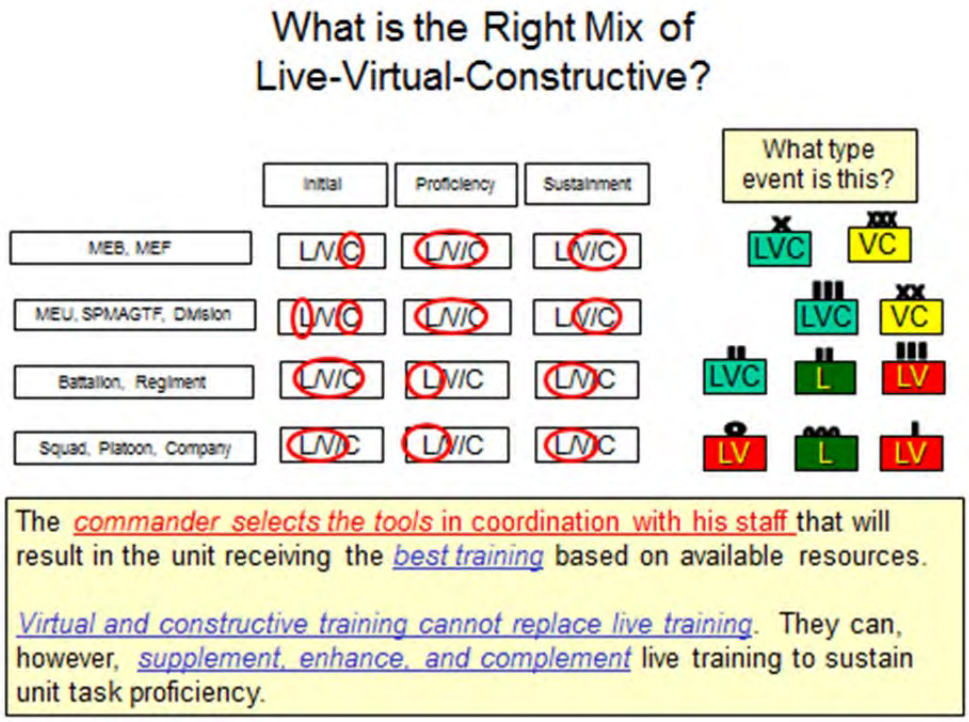

Figure 34. Method for determining what aspects of L-V-C to use (after FA57, 2014)

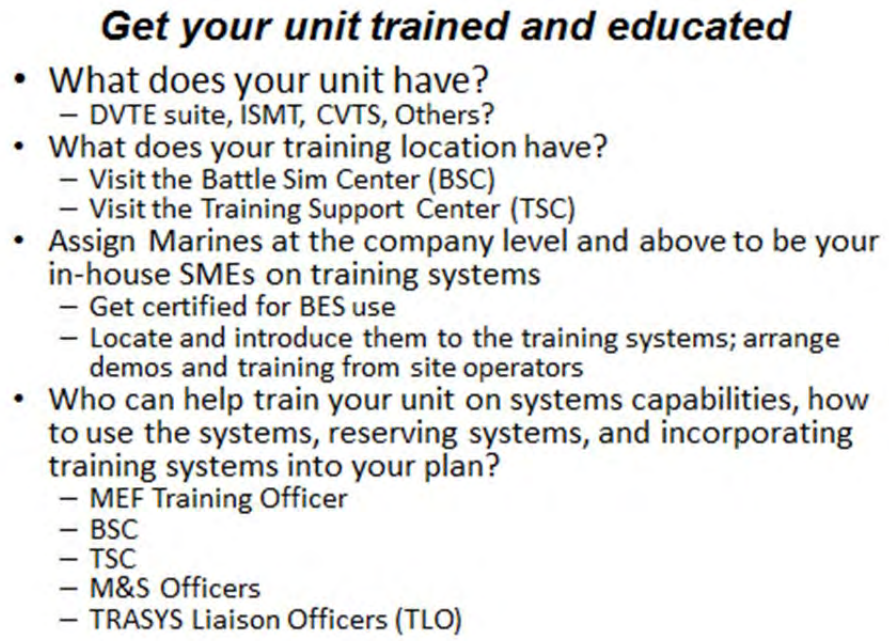

Figure 35. Recommendations for getting locally trained and educated

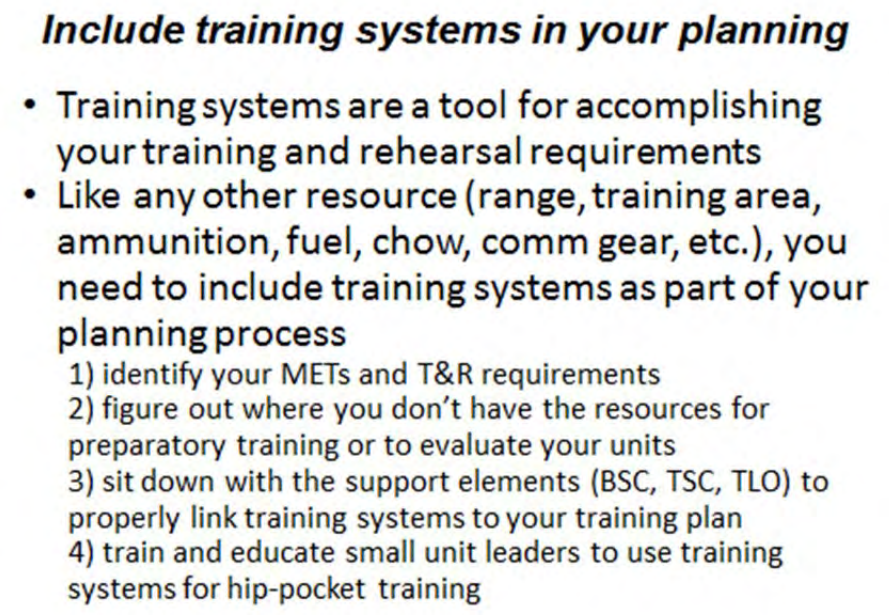

Figure 36. How to apply training systems against your training plan

b. Focus for Implementation

The Marine Corps needs to identify whom and where T&E for LVC-TE is to be provided. Education should be provided across EdCom but focused towards CSC, EWS, SNCO Advanced Course, and SNCO Career Course. Training should be focused towards MSTP and the professional courses under MAGTFTC. The MAGTFTC courses are those provided by the MCTOG (GCE focus), MCLOG (LCE focus), and MAWTS-1 (ACE focus). They collectively produce tactics instructors (TIs) through their extensive curriculums. Those TIs are operations and tactics instructors (OTI) (MCTOG), intelligence and tactics instructors (ITI) (MCTOG), expeditionary logistics (ELI) (MCLOG), and weapons and tactics instructors (WTI) (MAWTS-1). These instructors should become the backbone of LVC-TE ingenuity and employment in the Marine Corps. Demonstrated on the front end of the MAGTF Training Program in Figure 37; the TIs are well situated to have an impact throughout all unit level training.

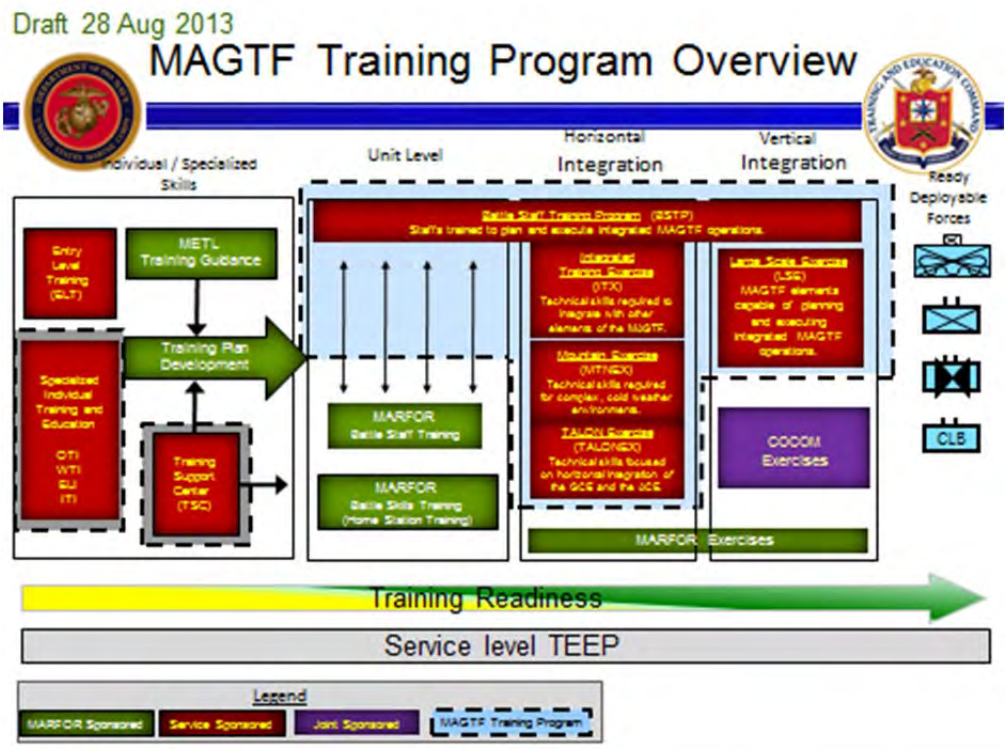

Figure 37. The MAGTF Training Program (from TECOM, 2013b)

2. Integration, Materiel, and Facilities

The solution for these areas relies on formally assigning personnel and adhering to processes. First, a CIO must be assigned to take LVC-TE process ownership. This individual should be a field grade officer with MAGTF staff experience. Lead action officers for the affected areas within the Marine Corps must be assigned as well. Once unity of command is established, then the Marine Corps can achieve unity of effort through integrated processes. Specific to training systems and LVC-TE, there are available processes for proper socialization, prioritization, and decisions to be made. Though currently held independently and irregularly, the Training M&S WIPT and MAGTF T&E OAG can provide the forums and sustained process for continued LVC-TE development in connection with other Marine Corps processes. Using the model followed by PP&O and the knowledge gained throughout my studies on this issue, Figure 38 is my proposal for this process.

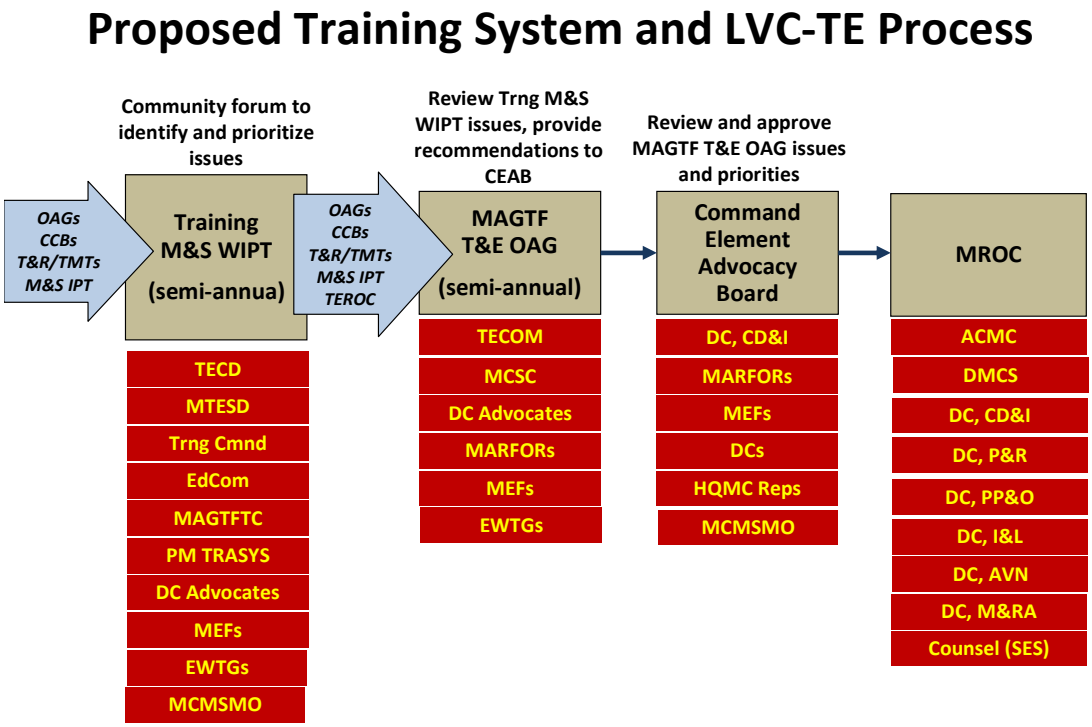

Figure 38. Proposed Training System and LVC-TE Process.

The lack of a CIO being assigned (in any capacity) to LVC-TE means that there is no control point for anything right now—information is not pulled and pushed from/to one single point, service level guidance is not being provided across HQMC agencies and the Marine Force (MARFOR) commands, and the DOTMLPF-P gaps are not being addressed through coordinated enterprise activities. Marine Corps LVC-TE achievements in 2014 have been somewhat by happenstance and certainly not by design.

Figure 39 is my identification of the key stakeholders for LVC-TE. As the title of the figure suggests, LVC-TE is a complicated issue and objective for the Marine Corps. The capabilities and T&R efficiency gains that have been presented in this paper will be delayed, immature, wrong, or simply never seen unless a full vision and strategy is developed and implemented.

LVC-TE: Why this is complicated

Functional Area	Responsible Agencies
Vision/Strategy/LVC-TE Advocate/Doctrine	DC, CD&I
Resource and requirements sponsor	TECOM (TECD), DCA
Materiel solution	MCSC (PM TRASYS, PM ISI, PM MC3, SIAT M&S, MCTSSA), NAWCTSD
T&E implementation/LVC-TE Proponent	TECOM
Facilities/Infrastructure	DC, I&L (MCICOM)
Network and IA	HQMC C4, MARFORCYBER (MCNOSC)
S&T/Experimentation	TECOM (TECD); DC, CD&I (MCWL); ONR; MCSC (PM TRASYS)
CE Advocate (Primary users)	DC, CD&I (CEAB); MEFs
ACE requirements/integration	DCA; CD&I (C2ID)
GCE requirements/integration	DC, PP&O; CD&I (FMID)
LCE requirements/integration	DC, I&L (LPC, LPV); CD&I (LID)
Naval integration	USMC?, Navy lead is NAVAIR (NAWCTSD)
Joint integration	USMC?, Joint lead is PEO STRI
Coalition integration	USMC?, Other?

Figure 39. LVC-TE Key Stakeholders

V. CONCLUSION

The Marine Corps is in the same position as the other military services—resources are decreasing while mission requirements remain steady and often increasing. Readiness is the key to achieving mission requirements—readiness with regards to training, manpower, equipment, and having Marines in the right places to respond to crisis. In order to be poised for this crisis response, the Marine Corps' has developed the EF-21 capstone concept. All readiness capabilities will need to support EF-21. LVC-TE offers the opportunity to dramatically change the way the Marine Corps achieves readiness in this resource challenged environment. In order for the Marine Corps to be poised to integrate LVC-TE's capabilities, LVC-TE must be included in institutional planning.

A. NEAR-TERM FOCUS

The primary near-term objective of LVC-TE is to take many of the Marine Corps' current training systems and allow them to operate together in a near-seamless and distributed manner (TECD, 2014). While necessary, this objective will prove to be cumbersome and costly if the Marine Corps continues to try and move forward without a designated CIO, identified actions officers across HQMC, and without a prescriptive process being followed.

B. LONG-TERM PLANNING AND OPPORTUNITIES

Without a firm understanding of the acquisitions process, I can see how one would read through this paper and think that the Marine Corps cannot afford many of the pursuits of LVC-TE–many components rely on undeveloped technology and a robust infrastructure that is not planned for–while competing against other programs and concerns within the Marine Corps. That is not the case. The Marine Corps does not need to direct the establishment of a new large IPT and program officer to manage this and does not need to allocate funds by taking away from other programs, but the Marine Corps also cannot wait for LVC-TE to fall in its lap. There are enough other agencies involved in these issues that the Marine Corps can leverage the work and resources of

others. The Marine Corps can even lead, or at least influence, these agencies to achieve specific Marine Corps requirements but not without engaged leadership, a vision and strategy, and an empowered CIO who can navigate the Marine Corps to positions of opportunity.

LVC-TE is not science fiction. Though some technology requirements still require maturity or have not even been identified yet, there is no deficiency in the number of organizations (in and out of the military) who are conducting research and development with relation to LVC-TE. Without a holistic vision and strategy that spans across the Marine Corps though, these organizations are generally unaware of how they can potentially tailor their efforts to fit LVC-TE and the Marine Corps is not able to engage these organizations as an educated user. There is still time for the Marine Corps to correct this and become a leader in this area.

C. FINAL THOUGHTS

The average Marine (including commanders) cannot look at any current LVC-TE vision products and statements and gain an implied understanding of how substantially LVC-TE will affect and support them. As such, they do not realize that this is a concept and capability that they must be engaged in so that it will properly support them now and in the future. Without a bolder and more comprehensive vision for LVC-TE, Marines and their leaders will continue to ignore it and LVC-TE will continue to fall short of its potential and of what the Marine Corps requires in order to achieve and maintain T&R in a fiscal environment that constantly requires greater efficiencies to be gained and demonstrated.

The technology cycle of the world is at an ever increasing pace that is quite simply in conflict with the acquisitions and FYDP cycles of the Marine Corps. The Marine Corps needs to be in a position to incorporate these technologies as they offer a cost-savings method to achieve T&R. While the Marine Corps may be facing budget limitations, the means by which it can achieve T&R, specifically for EF-21, are more robust than ever. LVC-TE will be a capability that is greater than the sum of its parts. LVC-TE will only be limited by the imagination of Marines but they cannot imagine new

possibilities if they are not aware of LVC-TE and its components. The Marine Corps can either institutionally continue to fall back on what it has done in the past (resource intensive live training and imperfect constructive training) or it can get out of its comfort zone and truly be the innovative organization that it claims to be by aggressively developing and implementing LVC-TE in order to achieve EF-21 goals under limited resources. This requires systemic change but systemic change cannot be achieved without a systemic plan. In order to do so, the Marine Corps needs to truly establish a vision and strategy for LVC-TE.

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APPENDIX A. USAGE REPORT DATA PROVIDED TO PM TRASYS

A. Operator Driver Simulator, 29 Palms, CA – February 2011 to December 2012

Date	# Trained	Miles		Date	#Trained	Mileage
Feb-11	77	3865		Jan-13	114	651
Mar-11	105	3300		Feb-13	112 VIP	303
Apr-11	155	4437		Mar-13	70	687
May-11	65	1569		Apr-13	85	1,356
Jun-11	139	3474		May-13	4	94
Jul-11	141	3947		Jun-13	56	1,101
Aug-11	130	3316		Jul-13	80	1,904
Sep-11	126	3822		Aug-13	80	914
Oct-11	100	3384		Sep-13	100	1,854
Nov-11	93	2301		Oct-13	26	620
Dec-11	19	539		Nov-13	41	904
Jan-12	51	1553		Dec-13	0	0
Feb-12	48	1408		Jan-14	190	1,679
Mar-12	65	2016		Feb-14	73	2,073
Apr-12	66	2002		Mar-14	5	124
May-12	154	3480		Apr-14	75	1,456
Jun-12	95	1748		May-14		
Jul-12	57	1641		Jun-14		
Aug-12	112	3033		Jul-14		
Sep-12	61	1918		Aug-14		
Oct-12	143	3070		Sep-14		
Nov-12	61	1316		Oct-14		
Dec-12	22	524		Nov-14		
				Dec-14		
Totals	2085	57663				

B. Combat Convoy Simulator – May 2013 to September 2013

Row Labels	Sum of Personnel Count	Sum of Scenario Time (minutes)
[2300001] Camp Upshur Unit #1	**294**	**960**
Culpepper HS JROTC, Marine Cadets of America	77	300
Fox 2/5 Reunion	52	120
Freedom Alliance	60	150
King William AFJROTC	36	90
NRA Youth Education Summit	54	120
Reserve Transition Retention Program	15	180
[2300002] Camp Upshur Unit #2	**438**	**2630**
4th CEB ESB	90	720
Charlie Co TBS	280	1350
Joint Transformation Command	16	180
Joint Transformation Command Intel	19	180
Marine Washington B Co 3rd Plt	33	200
[2300003]Camp Pendleton CCS 1	**1662**	**11219**
1 MEF ATC	20	273
1st CEB	151	766
1st CEB B CO	70	489
1st CEB C CO	22	234
1st CEB ESC	126	587
1st LE BN A CO	82	498
2/1 WPN	17	243
2/11 G	20	237
2/5 WPNS	60	694
250th Trans Co	32	277
3/1 H&S	9	354
31st Sea Bees	31	270
3rd ANGLICO	30	449
4th AABN	20	365
4th MED BN	42	254
7th ESB	78	559
CLB 453	25	105
CLB-5	27	364
DIVSCH	132	804
JROTC Yuma	23	55
MCAS YUMA	23	195
MTACS	13	383

None	0	0
Sea Cadet Corps	27	178
SOI IULC	60	570
SOI MLC	25	183
TSD VIP mud run sponsors	3	45
TSD VIP Navy League	10	65
TSD VIP NJROTC	21	104
TSD VIP So Cal Cadets	110	101
TSD VIP USBP Explorers	33	162
VIP Boy Scouts	40	205
VIP Channel 10 News	1	70
VIP Gen Coglianese	4	45
VIP JROTC	30	85
VIP JROTC #2	43	104
VIP MCB G3/5 OPS DIV	50	64
VIP MCI WEST	28	60
VIP Sea Cadet Corps	40	115
VIP TSD	3	71
VIP Wounded Warriors	2	45
VIP Young Marines	55	332
VIP-Young Marines	24	160
[2300004]Camp Pendleton CCS2	**758**	**6690**
1st CEB	4	243
1st LE BN A CO	80	678
2/1 WPN	10	243
2/11 G	16	237
2/5 WPNS	65	958
250th Trans Co	28	277
3/1 H&S	4	354
3rd ANGLICO	30	449
4th AABN	20	296
4th MED BN	43	254
7th ESB	70	581
CLB-5	23	328
JROTC Yuma	20	55
MCAS YUMA	22	195
None	0	0
SOI MLC	26	195
TSD VIP Boy Scouts	20	120
TSD VIP JROTC	40	85
TSD VIP NJROTC	15	104
TSD VIP USBP Explorers	20	162

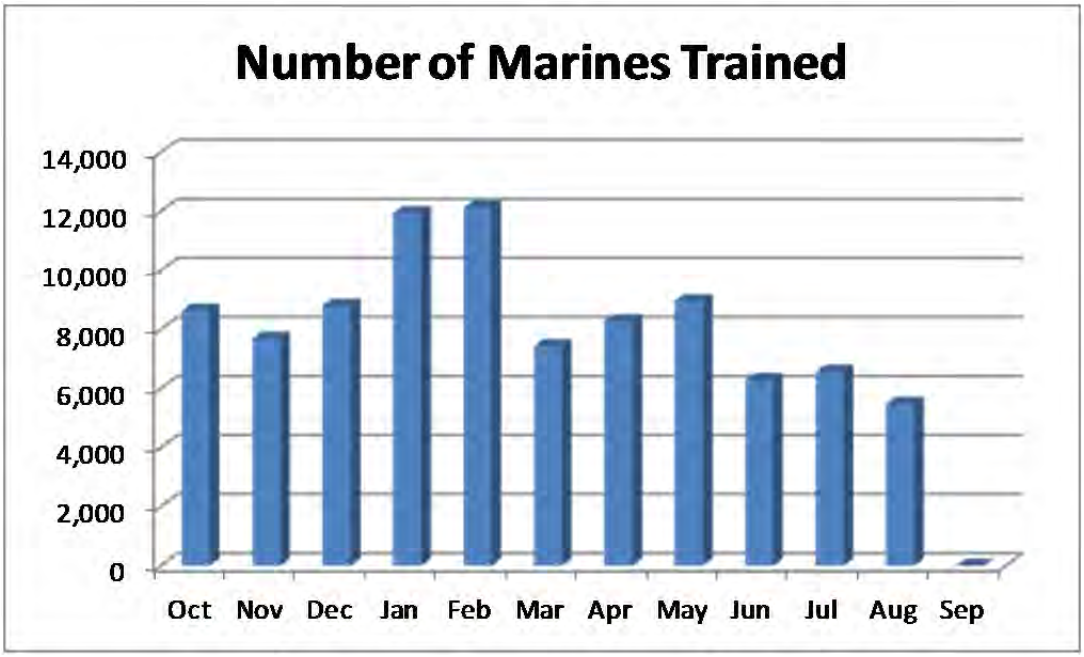
VIP 10 NEWS	5	45
VIP Boy Scouts	20	75
VIP JROTC	15	85
VIP JROTC #1	22	115
VIP JROTC #2	43	104
VIP Sea Cadet Corps	40	65
VIP Wounded Warriors	2	55
VIP Young Marines	55	332
[2300005]29 Palms-Operation and Training CCS	**1963**	**10375**
1/7 WPNs Plt	229	2020
1st Tanks Scout Plt	192	1290
1st Tanks Tow	120	945
2/3 STAY-FIST	72	450
29 Palms G5 VIP	7	60
3/7 Co L	16	120
3rd LAR Motor T	32	240
CLB-7	720	2580
CLB-7 CANC TRNG	0	0
CLB-7 Engineers	111	240
FED HOLIDAY	0	0
MCCS VIP/Visitors	5	60
MWSS 171	85	420
MWSS 272	40	240
No Unit scheduled Training	0	0
UAE (2/7)	48	360
3/7/2013	286	1350
[2300006]Kaneohe Bay	**242**	**1220**
0NA	0	0
3rd Marine Division CO	8	120
3RDRADBN	26	240
3rdRBN	18	400
NA	0	0
PAO ROTC	90	160
Singapore Military	60	60
1/3/2013	40	240
[2300007]Pt. Mugu	**607**	**6792**
425th Civil Affairs - Army Reserve	16	249
Army 425th Civil Affairs	42	457
Chief of Staff, NECC	2	60

EODGRU1, San Diego	8	57
Local PD	8	270
MWR Aquatics	16	189
N/A	0	0
NA	0	0
NMCB 17	24	237
NMCB 28	41	605
NMCB 28 BCS2	23	423
NMCB 28 Chiefs & Officers	36	357
NMCB 28 CSE	138	1630
NMCB 28 CSE course	128	873
NMCB28 BCS2	38	443
NMCB28 CSE	29	255
NMCB28 CSE Course	32	120
Pulau VP of HR	1	120
Tour, Command Master Chief NBVC	4	117
West LA Sea Cadets	21	330
[2300008]Camp Lejeune #1	**1385**	**22117**
2 MEF-8th Comm BN	18	453
2 MEF-ATC	73	944
2D ANGLICO	30	861
2D LAR	35	756
2D TANKS	148	2023
8th Comm BN	18	350
CLB 2	43	932
Div - 2D TANKS	66	679
Div 1/9	51	709
Div 2/9	76	316
Div 2D LAR	23	450
Div-1/9	70	1331
Div-3/8	64	1448
Div-AAV BN	32	908
Div-HQBN	28	312
Div-HQBN TRK CO	23	487
II MEF ATC	32	519
II MEF-ATC	40	422
JROTC-NC	60	120
MARSOC	67	869
MCCSSS	94	2383
MCCSSS-LOC	88	1596
MCCSSS-SNCO	21	253
MLG-8th ESB	20	483

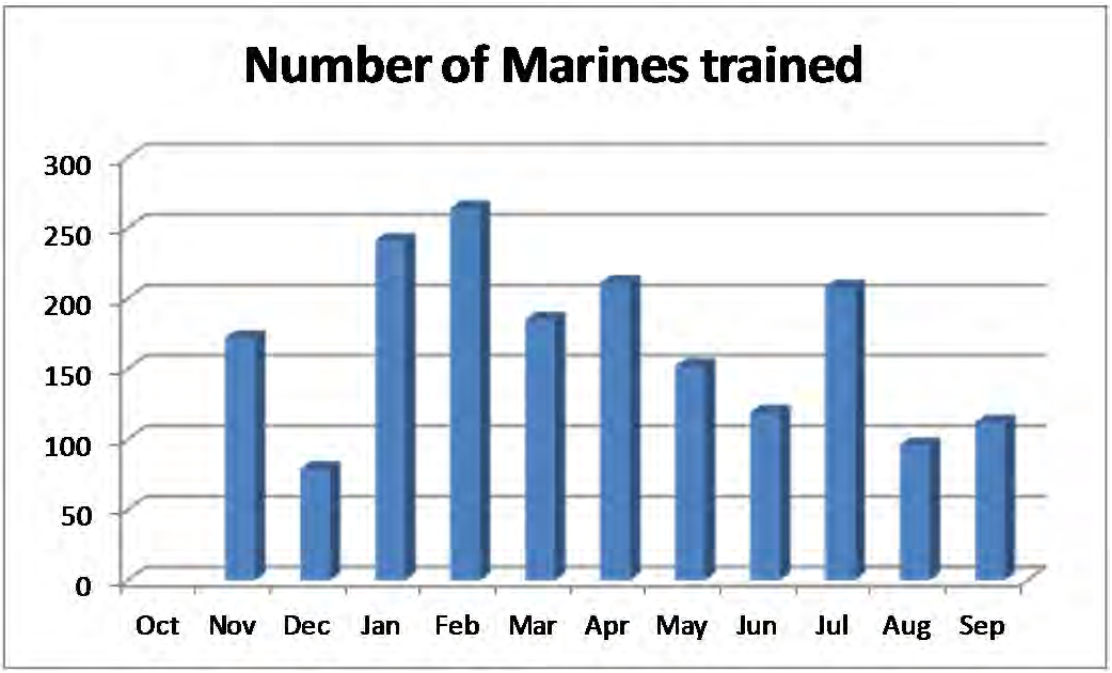
MLG-CLB 8	25	225
MWSS 272	29	279
MWSS-272	19	498
None	0	0
Scarlet & Gold Tour	35	30
SOI/AITB	17	491
SOI-AITB	40	990
[2300009]Camp Lejeune #2	**1074**	**21143**
2 MEF ATC	15	487
2D CEB	116	2377
2D LAR	37	746
2D TANKS	38	463
8TH Mar Reg	19	494
CLB-2	38	924
Div - 2D LAR	18	239
Div 1/9	97	1723
Div HQBN TRK CO	27	358
Div/3/8	16	478
Div-1/6	14	447
Div-1/8	16	315
Div-1/9	70	1394
Div-2/10	36	348
Div-3/8	32	370
Div-HQBN	19	330
JROTC-NC	60	120
MARSOC	44	1267
MCCSSS	92	2291
MCCSSS-LOC	87	1857
MCCSSS-NCO	54	954
MCCSSS-SNCO	21	431
MLG-8th ESB	20	503
MLG-CLB 2	35	513
MWSS-272	20	905
None	0	0
SOI-AITB	33	809
[2300010]Okinawa	**1109**	**8830**
1–1 ADA	56	135
3rd HQBN CANC	0	0
3RD LE	244	2988
3rd LE A co	60	168
3rd LE B Co.	27	214

3rd LE BN A Co	72	351
3RD LE CANC	0	0
3rd MAR	95	1196
3RD MED	23	181
3RD MED CANC	0	0
3RD MED CANCELED	0	0
4th MAR CANC	0	0
5th Anglico	15	202
9TH ESB	30	257
BLT 1/5	94	530
BLT 1/5 CANC	0	0
BLT 2/4	71	737
CLB 31	48	245
Japanese Defence Forces	77	79
JROTC, USAF JA932	22	171
MWSS 172	20	327
N/A	0	0
None	0	0
SOTG	15	172
U.S. ARMY 10 ASG	44	178
USA 10 ASG	35	73
USA 10 RSG & 4th MAR	42	532
3/12/2013	19	94
[2300011] Gulfport	**1420**	**4830**
BC-2	64	360
C169 U.S. Army	11	120
Cheif Slect	36	120
ECS	712	1800
ION TV Network	2	30
JROTC	50	60
JROTC Gauiter	71	120
JROTC Gautier	59	60
NMCB 27	17	180
NMCB-1	78	240
NMCB-74	94	240
Seacidets	12	120
U.S. army	54	300
U.S. Army C169	160	1080
(blank)		
Grand Total	**10952**	**96806**

C. Indoor Simulated Marksmanship Trainers, Camp Lejeune, North Carolina – October 2012 To August 2013



D. Supporting Arms Virtual Trainer, Camp Lejeune, North Carolina – October 2012 To September 2013



APPENDIX B. CACCTUS INITIAL DEVELOPMENT PLAN

A. FY13:

1. New Capability

a. CCB Part 2—Fuses, Corrections, Trajectory (CDD 6.1.4, 6.1.11, 6.2.1, 6.2.5.4, 6.2.5.5, 6.2.3.11, 6.2.5.1, 6.2.5.4)

b. Amphibious Operations—Phase I (CDD 6.2.1; 6.2.3.11)

c. Backward compatibility for scenario development (CDD 6.2.3.13)

d. After Action Review System—Phase II (CDD 6.1.9)

e. VBS2 Integration—Phase II (CDD 6.2.2)

f. Battery-level AFATDS functionality (CDD 6.1.7.1, 6.1.12)

g. Return on Investment/Cost Avoidance

h. Virtual Tactical Bridge enhancements (CDD 6.1.7)

i. New terrain: Korea, Camp Pendleton, 29 Palms, Hawaii MOUT (CDD 6.1.8)

j. Increase CACCTUS-OneSAF entity count to 3000 entities (CDD 6.1.4)

k. OneSAF Virtualization

2. Sustainment

a. PDSS (PTR resolution, IA maintenance, CM, C4ISR upgrades, Terrain)

b. Hardware refresh Camp Lejeune

c. OneSAF-CACCTUS step up/integration

B. FY14:

1. New Capability

a. Amphibious Operations—Phase II (CDD 6.2.1, 6.2.3.11)

b. Regimental-level (RCT) Exercise Capability (CDD 6.2.1)

(1) 5K Semi-Autonomous Force (SAF) entities CDD 6.1.4)

(2) COP Management / COC interface (SAF and HITL to C4I) (CDD 6.1.12, 6.1.7.1)

(3) MAGTF C2—TBMCS, CAPSET III COC, MiRC Chat, PASS/DDS, VOIP, JADOCS

(4) CCSM Enhancements (CDD 6.2.4)

c. Distributed Operations—Phase I (CDD 6.2.1, 6.2.2) CAST-to-CAST

d. Improved Fires Capabilities (CDD 6.2.3.11, 6.2.5.4, 6.2.5.5) Realistic Trajectories, shell/fuze combos, and air burst

e. Environment Effects– Phase I (CDD 6.1.11, 6.2.3.8) Night Ops / All Weather Ops

f. Tailored Vulnerability Models (CDD 6.1.6)

2. Sustainment

a. PDSS (PTR resolution, IA maintenance, CM, C4ISR upgrades, Terrain)

b. Hardware refresh Camp Pendleton

c. OneSAF-CACCTUS step up/integration

C. FY15:

1. New Capability

a. Current Threat OPFOR modeling improvements (CDD 6.1.5, 6.2.3.3, 6.2.5.4)

b. Distributed Operations—Phase II (CDD 6.1.1, 6.2.1, 6.2.2)

(1) Flight simulator distributed integration (F/A-18, AC-130, A/V-8B, M/V-22) (CDD 6.2.2.1, 6.1.11)

(2) MISTE / LVC-TE integration—Phase I (CDD 6.2.2.2, 6.2.2.3)

(3) Interoperability with VMU UAS Shadow simulator (CDD 6.2.3.9, 6.2.2.1)

(4) CACCTUS with HLA (CDD 6.2.2.3)

(5) AAR—Phase III (CDD 6.1.9, 6.2.2.2)

c. Upgrades to Marine Digital Voice (MDV) (CDD 6.1.7)

d. Environmental Effects—Phase II (CDD 6.2.3.8, 6.1.11) Wind drift and dispersion (NBC)

e. Add Aural/Sound indications to system

2. Sustainment

a. PDSS (PTR resolution, IA maintenance (IV&V), CM, C4ISR upgrades, Terrain)

b. Hardware refresh Marine Corps Base Kaneohe Hawaii

c. OneSAF-CACCTUS step up/integration (20K+ entities)

D. FY16:

1. New Capability

a. MEB level exercise capability (CDD 6.2.1)

(1) DASC, TACP, TACC, FDCs and FSCCs requires additional organic C4I (CDD 6.1.12)

(2) More complex modeling and Semi-Autonomous Forces (SAF) behaviors (CDD 6.1.4, 6.1.5)

b. Distributed Operations—Phase III (CDD 6.1.1, 6.2.1, 6.2.2)

c. MISTE / LVC-TE Phase II (CDD 6.2.2.2, 6.2.2.3)

2. Sustainment

a. PDSS (PTR resolution, IA maintenance, CM, C4ISR upgrades, Terrain, MISTE / LVC-TE sustainment)

b. Refresh Camp Butler, Okinawa

c. New Army OneSAF-CACCTUS step up/integration

E. FY17:

1. New Capability

a. Distributed Operations—Phase IV (CDD 6.1.1, 6.2.1, 6.2.2)

b. MISTE / LVC-TE Phase III (CDD 6.2.2.2, 6.2.2.3)

2. Sustainment

a. PDSS (PTR resolution, IA maintenance, CM, C4ISR upgrades, Terrain, MISTE / LVC-TE sustainment)

b. Hardware Upgrades

c. New Army OneSAF-CACCTUS step up/integration (30K+)

d. CACCTUS VV&A in preparation for FOC

F. FY18: (FOC) - Sustainment

1. PDSS (PTR resolution, IA maintenance (IV&V), CM, C4ISR upgrades, Terrain, MISTE / LVC-TE sustainment)

2. Hardware Upgrades

3. New Army OneSAF-CACCTUS step up/integration (30K+)

4. **CACCTUS VV&A in preparation for FOC**

APPENDIX C. CACCTUS REVISED DEVELOPMENT PLAN

A. FY13:

1. New Capability

a. **CCB Part 2—Fuses, Corrections, Trajectory (CDD 6.1.4, 6.1.11, 6.2.1,** 6.2.5.4, 6.2.5.5, 6.2.3.11, 6.2.5.1, 6.2.5.4) (ensure realistic effects on target w/ dispersion)

b. Battery-level AFATDS functionality (CDD 6.1.7.1, 6.1.12)

c. VBS2 Integration—Phase II (CDD 6.2.2) (based on results of Phase I; independent hardware enhancement)

d. Amphibious Operations—Phase I (CDD 6.2.1; 6.2.3.11) (provide NSFS capability; NGF IFW)

e. FBCB2 Integration (dependent on receipt of equipment)

f. Return on Investment/Cost Avoidance (ensure ability to pull separate daily/scenario/exercise reports, every munition, how encompassing does report need to be (T&R events, personnel trained))

g. OneSAF Virtualization (putting headless nodes on racks)

h. Distributed Operations—Phase I (CDD 6.2.1, 6.2.2) (exploratory, proof of concept?, clock synchronization)

i. After Action Review System—Phase II (CDD 6.1.9) (will help to first use current AAR ability)

j. Backward compatibility for scenario development (CDD 6.2.3.13) (moved to FY15, initial capability will be part of 6.0)

k. Virtual Tactical Bridge enhancements (CDD 6.1.7) (NAVAIR task)

l. New terrain: Korea, Camp Pendleton, 29 Palms, Hawaii MOUT (CDD 6.1.8)

m. Increase CACCTUS-OneSAF entity count to 3000 entities (CDD 6.1.4)

2. Sustainment

a. PDSS (PTR resolution, IA maintenance, CM, C4ISR upgrades, Terrain)

b. Hardware refresh Camp Lejeune; IOS v1 hardware/software replacement; FBCB2 fielding

c. OneSAF-CACCTUS step up/integration

B. FY14:

1. New Capability

a. Regiment operations

(1) Regimental-level (RCT) Exercise Capability (CDD 6.2.1)

(2) 5K Semi-Autonomous Force (SAF) entities CDD 6.1.4)

(3) COP Management / COC interface (SAF and HITL to C4I) (CDD 6.1.12, 6.1.7.1)

(4) MAGTF C2—TBMCS, CAPSET III COC, MiRC Chat, PASS/DDS, VOIP, JADOCS

(5) CCSM Enhancements (CDD 6.2.4)

b. Amphibious Operations—Phase II (CDD 6.2.1, 6.2.3.11) (ship-to-shore movements, what can we gain first from tie in with other systems?)

c. Environment Effects (CDD 6.1.11, 6.2.3.8) (depends on 3D viewer, may not be necessary) Wind drift and dispersion (NBC) / Night Ops / All Weather Ops

d. Tailored Vulnerability Models (CDD 6.1.6)

e. Distributed Operations—Phase I (CDD 6.2.1, 6.2.2) (moved to FY13) CAST-to-CAST

f. ~~Improved Fires Capabilities (CDD 6.2.3.11, 6.2.5.4, 6.2.5.5)~~ (CCB Part 2 should account for this but will reevaluate after deployed) Realistic Trajectories, shell/fuze combos, and air burst

2. Sustainment

a. PDSS (PTR resolution, IA maintenance, CM, C4ISR upgrades, Terrain)

b. Hardware refresh Camp Pendleton

c. OneSAF-CACCTUS step up/integration

C. FY15:

1. New Capability

a. Current Threat OPFOR modeling improvements (CDD 6.1.5, 6.2.3.3, 6.2.5.4)

b. Distributed Operations—Phase II (CDD 6.1.1, 6.2.1, 6.2.2)

(1) Flight simulator distributed integration (F/A-18, C-130, A/V-8B, M/V-22, F-35, RW?) (CDD 6.2.2.1, 6.1.11)

(2) MISTE / LVC-TE integration—Phase I (CDD 6.2.2.2, 6.2.2.3)

(3) Interoperability with VMU UAS Shadow simulator (CDD 6.2.3.9, 6.2.2.1)

(4) CACCTUS with HLA (CDD 6.2.2.3)

(5) AAR—Phase III (CDD 6.1.9, 6.2.2.2)

c. Upgrades to Marine Digital Voice (MDV) (CDD 6.1.7)

d. Backward compatibility for scenario development (CDD 6.2.3.13) (moved from FY13—assess for MSDL and C2PC translation needs)

e. Environmental Effects—Phase II (CDD 6.2.3.8, 6.1.11) (combine into one effort in FY14) ~~Wind drift and dispersion (NBC)~~

f. ~~Add Aural/Sound indications to system~~ (plan to include in VBS2 hardware enhancement in FY13)

2. Sustainment

a. PDSS (PTR resolution, IA maintenance (IV&V), CM, C4ISR upgrades, Terrain)

b. Hardware refresh Marine Corps Base Kaneohe Hawaii

c. OneSAF-CACCTUS step up/integration (20K+ entities)

D. FY16:

1. New Capability

a. MEB level exercise capability (CDD 6.2.1)

b. DASC, TACP, TACC, FDCs and FSCCs requires additional organic C4I (CDD 6.1.12) and more complex modeling and Semi-Autonomous Forces (SAF) behaviors (CDD 6.1.4, 6.1.5)

c. Distributed Operations—Phase III (CDD 6.1.1, 6.2.1, 6.2.2)

d. MISTE / LVC-TE Phase II (CDD 6.2.2.2, 6.2.2.3)

2. Sustainment

a. PDSS (PTR resolution, IA maintenance, CM, C4ISR upgrades, Terrain, MISTE / LVC-TE sustainment)

b. Refresh Camp Butler, Okinawa

c. New Army OneSAF-CACCTUS step up/integration

E. FY17:

1. New Capability

a. Distributed Operations—Phase IV (CDD 6.1.1, 6.2.1, 6.2.2)

b. MISTE / LVC-TE Phase III (CDD 6.2.2.2, 6.2.2.3)

2. Sustainment

a. PDSS (PTR resolution, IA maintenance, CM, C4ISR upgrades, Terrain, MISTE / LVC-TE sustainment)

b. Hardware Upgrades

c. New Army OneSAF-CACCTUS step up/integration (30K+)

d. CACCTUS VV&A in preparation for FOC

F. FY18: (FOC) - Sustainment

1. PDSS (PTR resolution, IA maintenance (IV&V), CM, C4ISR upgrades, Terrain, MISTE / LVC-TE sustainment)

2. Hardware Upgrades

3. New Army OneSAF-CACCTUS step up/integration (30K+)

4. CACCTUS VV&A in preparation for FOC

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APPENDIX D. BRIEFINGS, MEETINGS, AND CONFERENCES

A. April 2013, GCE COAG, Quantico, Virginia

B. August 2013, Senior Gunner's Symposium, Quantico, Virginia

C. August 2013, PP&O POG Advocates, Washington, D.C.

D. August 2013, I&L LPC-3 Advocate, Washington, D.C.

E. August 2013, DC, CD&I, C2ID

F. August 2013, Director MTESD

G. September 2013, Inspector and instructor Conference, New Orleans, Louisiana

H. September 2013, DC, CD&I, FMID, MID, and LID, Quantico, Virginia

I. October 2013, USMC M&S IPT, Quantico, Virginia

J. November 2013, LSE-14 IPC, 29 Palms, California

K. November 2013, I&L T&E OAG, 29 Palms, California

L. November 2013, NPS MOVES Brown Bag, Monterrey, CAlifornia (telecon)

M. December 2013, MAGTF Fires OAG, Quantico, Virginia (telecon)

N. December 2013, I/ITSEC, Orlando, Florida

O. January 2014, i mef commanding general, Camp Pendleton, California

P. January 2014, I MEF Proof of Concept, Camp Pendleton, California

Q. February 2014, I MEF LVC WG, Orlando, Florida

R. February 2014, LSE-14 MPC, 29 Palms, California

S. March 2014, MAGTF T&E OAG, Quantico, Virginia

T. March 2014, APW-71, APX, and POG, Washington, D.C.

U. April 2014, The Basic School, Quantico, Virginia

V. April 2014, Combat Marksmanship Symposium, Quantico, Virginia

W. April 2014, OAD study group, Quantico, Virginia

X. April 2014, USMC M&S IPT, Quantico, Virginia

Y. April 2014, ATF&PD, Quantico, Virginia

Z. May 2014, LSE-14 FPC, 29 Palms, California

AA. May 2014, I&L T&E OAG, 29 Palms, California

BB. 3–5 June 2014, MAGTF Fires OAG, Quantico, Virginia

CC. 24–26 June 2014, I MEF LVC Summit, Orlando, Florida

DD. 8 July 2014, IWOC instruction, Quantico, Virginia

EE. July 2014, HQMC Action Officers, Washington, D.C.

FF. July 2014, Director ATF&P, Quantico, Virginia

GG. August 2014, LSE-14 FINEX, 29 Palms, California

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